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Ground-Water Resources along the Little Bighorn River, Crow Indian Reservation, Montana

Water-Resources Investigations Report 03-4052

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

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By L.K. Tuck

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Helena, Montana
June 2003

In cooperation with the
BUREAU OF INDIAN AFFAIRS

U.S. Department of the Interior

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

Multiply	By	To obtain
acre	4,047	square meter
acre-foot per year (acre-ft/yr)	1,233	cubic meter per year
cubic foot per second (ft^3/s)	0.028317	cubic meter per second
foot (ft)	0.3048	meter
foot per day (ft/d)	0.3048	meter per day
foot squared per day (ft^2/d)	0.09290	meter squared per day
foot per mile (ft/mi)	0.1894	meter per kilometer
gallon per day (gal/d)	0.003785	cubic meter per day
gallon per minute (gal/min)	0.06309	liter per second
gallon per minute per foot [(gal/min)/ft]	0.2070	liter per second per meter
inch (in.)	25.40	millimeter
mile (mi)	1.609	kilometer
square mile (mi^2)	2.590	square kilometer

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

°F = 9/5(°C)+32.

Vertical coordinate information is referenced to the National Geodetic Vertical Datum of 1929 (NGVD 29). Horizontal coordinate information is referenced to the North American Datum of 1927 (NAD 27), unless otherwise noted.

Water year: The 12-month period October 1 through September 30. It is designated by the calendar year in which it ends.

Abbreviated water-quality units used in this report:

µS/cm	microsiemens per centimeter at 25 degrees Celsius
µg/L	micrograms per liter
mg/L	milligrams per liter
pCi/L	picocuries per liter

Acronyms used in this report:

BIA	Bureau of Indian Affairs, U.S. Department of the Interior
CEPP	Crow Environmental Protection Program
EPA	U.S. Environmental Protection Agency
GIS	Geographic Information System
IHS	Indian Health Service
MCL	U.S. Environmental Protection Agency Maximum Contaminant Level
NWIS	National Water Information System
SDWR	U.S. Environmental Protection Agency Secondary Drinking-Water Regulation
USGS	U.S. Geological Survey

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ABSTRACT

This report describes the general geology and the water resources of Quaternary alluvium and the Upper Cretaceous Judith River Formation along the Little Bighorn River within the Crow Indian Reservation of southeastern Montana. Data were collected and compiled for 193 ground-water sites and 27 surface-water sites.

Quaternary alluvium underlies an area of about 94 square miles located primarily along the Little Bighorn River and is composed of unconsolidated gravel, sand, silt, and clay. Thickness of the probable water-bearing zone within the alluvium ranges from 2 to 39 feet, with a median of 9 feet. The specific capacity of wells completed in Quaternary alluvium ranged from 0.31 to 30 gallons per minute per foot [(gal/min)/ft], transmissivity estimates ranged from 230 to 6,900 feet squared per day (ft^2/d), and well yields ranged from 4 to 50 gallons per minute (gal/min). Low specific capacity, transmissivity, and well yield are typical of alluvium deposited by rivers having a small carrying and sorting capacity, which results in deposits containing substantial quantities of fine-grained material. Discontinuous or poorly connected lenses of coarser-grained material are also typical.

Recharge to Quaternary alluvium is by infiltration and subsequent percolation of precipitation, canal leakage, excess applied irrigation water, bank storage, and by subsurface inflow from alluvium in small ephemeral tributaries adjacent to the Little Bighorn valley and from the underlying Judith River Formation. Discharge from Quaternary alluvium is primarily through evapotranspiration, withdrawals from wells, flow to irrigation drains, and subsurface outflow to the Little Bighorn River. Ground water was estimated to contribute about 15 to 18 percent of the annual daily mean streamflow (in water year 1995) of the Little Bighorn River near Hardin.

Water in Quaternary alluvium generally had high concentrations of dissolved calcium, magnesium, sodium, bicarbonate, sulfate, chloride, and iron. Dissolved-solids concentrations ranged from 264 to 4,770 milligrams per liter (mg/L), with a median of 1,450 mg/L. The chemical quality of water from alluvium varied and some water can pose a health risk for domestic use.

The Upper Cretaceous Judith River Formation contains an unnamed upper member composed of about 700 feet of sandstone interbedded with sandy shale and shale and a lower member, the Parkman Sandstone Member, which is composed of as much as 350 feet of massive sandstone and sandy shale. Specific capacity of wells completed in the Judith River Formation ranged from 0.06 to 7.4 (gal/min)/ft, transmissivity estimates from specific-capacity tests ranged from 39 to 780 ft^2/d, and well yields ranged from 5 to 74 gal/min. Low specific capacity, transmissivity, and well yield are typical of the upper part of the Judith River Formation where interbedded shale and fine-grained sandstone can be lenticularly bedded and laterally discontinuous. The lower part of the Judith River Formation (Parkman Sandstone Member) is a fine-grained sandstone that is massive locally, but also is not uniform throughout the study area.

Recharge to the Judith River Formation is by infiltration and subsequent percolation of precipitation, infiltration of streamflow across outcrops, canal leakage, bank storage, and by subsurface inflow from Quaternary high-terrace deposits. Discharge from the Judith River Formation is primarily through upward subsurface outflow to Quaternary alluvium and the Little Bighorn River, withdrawals from wells, and evapotranspiration.

The major-ion composition of most water in the Judith River Formation was predominated by sodium, bicarbonate, and sulfate. Dissolved-solids concentrations in water from the Judith River Formation ranged from 352 to 1,910 mg/L, with a median of 1,000 mg/L. The chemical quality of water from the Judith River Formation varied and is probably suitable for most domestic use.

INTRODUCTION

The Little Bighorn River drains about 1,300 mi^2 of mountains, foothills and valleys. Some of the drainage area is in the Bighorn Mountains of Wyoming, but about 1,100 mi^2 of the drainage area is located on the Crow Indian Reservation in southeastern Montana (fig. 1). On the Reservation, the Little Bighorn River flows north for a distance of about 80 mi through foothills and the alluvial valley. Because of its meandering, the distance along the main river channel (river miles) is about 120 mi. Perennial tributaries to the Little Bighorn River include Lodge Grass and Pass Creeks; large ephemeral tributaries include Owl and Reno Creeks.

The principal land uses of the area are agricultural, including irrigated alfalfa, pasture grass, corn, and sugar beet production along the irrigated valley. Grass-covered rangeland for cattle production is interspersed with nonirrigated farmland along the higher terraces and foothills.

The Little Bighorn River and Lodge Grass and Pass Creeks are important sources of water for irrigation, although most water used for irrigation is diverted from the Little Bighorn River. Terraces along the river and adjacent areas are irrigated by this water. Lodge Grass Storage Reservoir, located near Lodge Grass Creek about 30 river miles upstream from its confluence with the Little Bighorn River, stores water diverted from Lodge Grass Creek to supply the Lodge Grass Canal No. 1 (pl. 1). Water from the Little Bighorn River also is used for municipal supply for the Town of Crow Agency.

Beyond the municipal boundaries of Crow Agency, water from Quaternary alluvium and the Upper Cretaceous Judith River Formation is the primary source for domestic and stock supplies. Shallow ground water (less than about 100 ft below land surface) generally is not available for domestic and stock use in areas where the alluvium or the Judith River Formation do not exist. Quaternary alluvium along the Little Bighorn River underlies flood plains and adjacent terraces and consists of unconsolidated gravel, sand, silt, and clay. The Judith River Formation crops out generally along or west of the Little Bighorn River and Pass Creek and underlies alluvium along most of the Little Bighorn River valley.

Information about the ground-water resources along the Little Bighorn River in Montana was limited. A better understanding of aquifer hydraulic characteristics, potentiometric surface, water quality, and interactions between the aquifers and the Little Bighorn River and other hydrogeologic units in the study area was needed to help address water-rights issues and water-quality concerns, and provide a better basis for water-management decisions. Consequently, the U.S. Geological Survey (USGS), in cooperation with the Bureau of Indian Affairs (BIA), conducted a study to obtain additional information to characterize the ground-water resources along the Little Bighorn River.

This report describes the general geology and the water resources of the Quaternary alluvium and the Upper Cretaceous Judith River Formation along the Little Bighorn River within the Crow Indian Reservation of southeastern Montana. The report contains hydrogeologic maps of the area and describes major aquifers along the Little Bighorn River, including their water-yielding characteristics and water quality.

Data were collected and compiled for 193 ground-water and 27 surface-water sites. Availability and quality of ground water were determined from inventory, periodic water-level measurements, and sampling of ground water. Data from the Indian Health Service (IHS) Hospital, Crow-Northern Cheyenne Public Health Service, also were compiled to determine aquifer geometry, characteristics, and water quality. Data from five streamflow-gaging stations were compiled and used to evaluate interactions between the aquifers and the Little Bighorn River.

Previous Investigations

The first investigation in the study area conducted by Thom and others (1935) was a reconnaissance principally of geography, drainage, and geology but included information about the water resources of the area. Moulder and others (1960) conducted a reconnaissance in the early 1950s of ground water along the northern part of the Little Bighorn River from near Lodge Grass to Hardin. The geology and ground-water resources were investigated, but the study focused primarily on factors affecting drainage of irrigated and irrigable land, and effects of irrigation on ground water. Richards (1955), Bergantino (1980), and Kanizay (1986a, b) mapped the geology or compiled geologic information in the study area.

Methods of Investigation

Hydrogeologic data were collected during 1994-95 by inventorying 192 existing wells and one spring. Data included well location, altitude of land surface, use of water, depth of well, diameter of well casing, static-water level, and well yield. Onsite water-quality

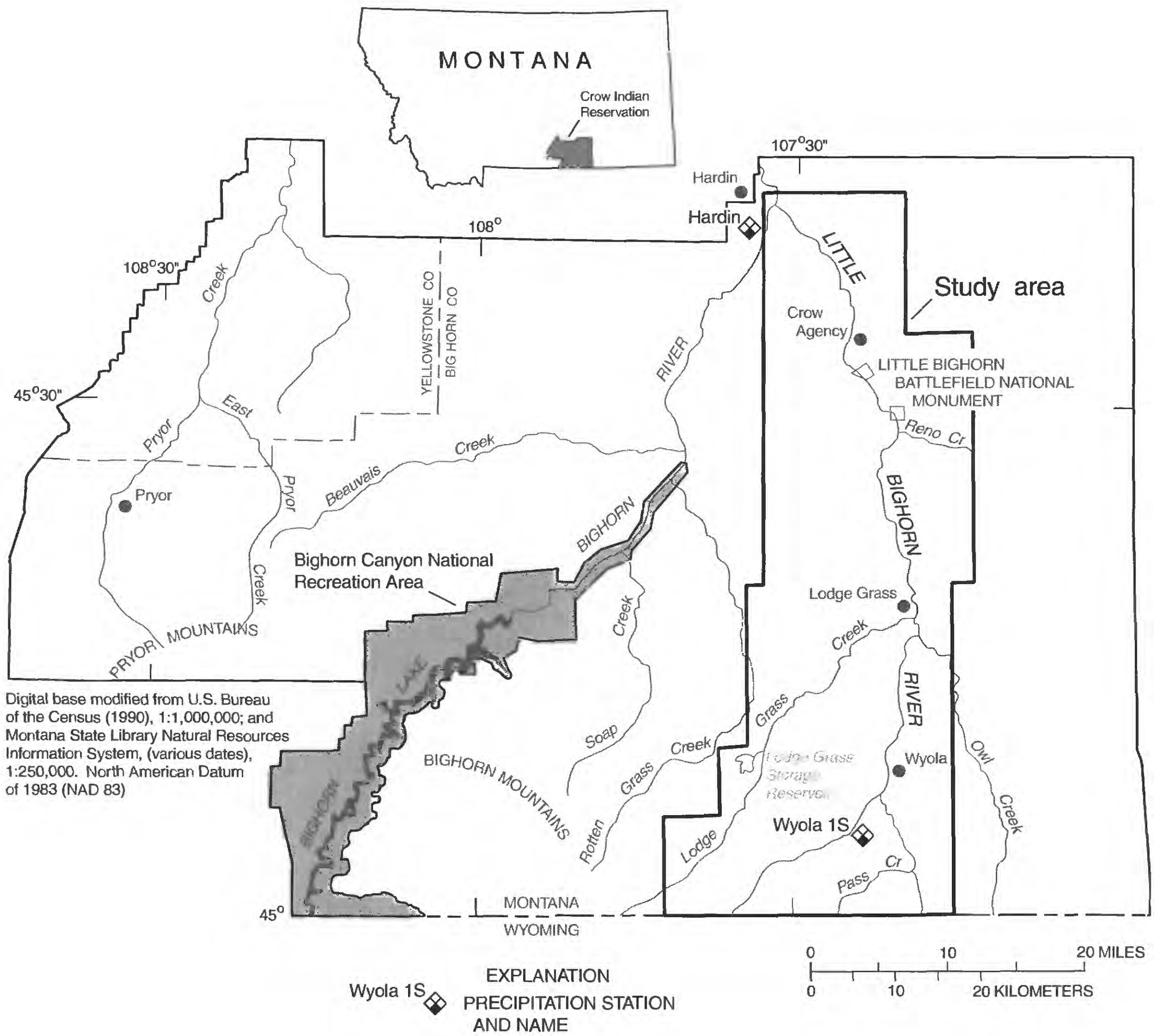


Figure 1. Location of the study area in Montana.

properties determined during the well inventory included specific conductance, pH, and water temperature (table 4 at back of report). In addition, drillers' logs were used when available to obtain information about well completion, specific capacity, aquifer composition and geometry, and whether aquifers were confined or unconfined. Selected wells were measured periodically to document water-level changes and evaluate the interactions between the aquifers and the Little Bighorn River and irrigation canals (table 5 at back of report).

Transmissivity was estimated from specific-capacity tests using data collected during the well inventory or data from drillers' logs (table 6 at back of report). These estimates were derived from a modified Theis equation that estimates transmissivity from specific-capacity tests for confined conditions (Heath, 1983, p. 60-61):

$$T = \frac{W(u)}{4\pi} \times \frac{Q}{s} \qquad (1)$$

where:

T = the estimated transmissivity, in ft^2/d,

$\frac{Q}{s}$ = the specific capacity determined during the well inventory or from data from the drillers' log, in (gal/min)/ft,

Q = pumping rate, in gal/min,

s = the water-level drawdown in the well,

$\frac{W(u)}{4\pi}$ = the well function of u,

where:

$$u = \frac{r^2 S}{4Tt} \qquad (2)$$

where:

r = the radius of the well (in ft),

S = based on a previously determined storage coefficient (dimensionless)

T = based on a previously determined transmissivity (in ft^2/d), and

t = the length of the pumping period (in hours).

Heath (1983, p. 35) presented a table of values of $W(u)$ for values of $1/u$ which allowed the value of $W(u)$ to be substituted into equation 1. An average storage coefficient of 0.00038 and an average transmissivity of 3,000 ft^2/d for Quaternary alluvium and an average storage coefficient of 0.0005 and average transmissivity of 1,750 ft^2/d for the Upper Cretaceous Judith River Formation (Moulder and others, 1960) was used for these calculations.

Most wells completed in the alluvium were installed with a 5-ft length of stainless-steel screen. In most places the thickness of the water-bearing zone ranged from 5 to 13 ft. Thus, in many wells completed in the alluvium, either the entire thickness or much of the thickness of the aquifer was penetrated and open to the screen. For wells completed in the Judith River Formation, the entire thickness of the aquifer was not fully penetrated, so only the area adjacent to the well screen contributed water to the well. Transmissivity was not estimated for unconfined conditions because most drillers' logs reported that water levels declined substantially in the pumped well; thus, the saturated thickness of the aquifers near the well probably was substantially decreased.

A synoptic-streamflow investigation was conducted on October 25, 1994, during near base-flow conditions to help determine ground- and surface-water interactions. Three two-person teams measured main-stem streamflow, major tributary streamflow, and selected canal diversions along three different reaches of the Little Bighorn River. Two sites, S11 and S16 (pl. 1), were measured twice as one team started and one team ended with these sites. A reconnaissance of minor tributaries on October 26, 1994, determined that streamflow from these sources did not increase flow of the Little Bighorn River during the synoptic-streamflow investigation. Specific conductance of streamflow also was measured at each site. Streamflow was measured using standard USGS methods described by Rantz and others (1982).

Water-quality and quality-assurance samples were collected from selected wells to assess ground-water quality in the study area (table 7 at back of report). Ground-water samples were obtained from existing pump systems at a discharge point as close to each well as possible. Water-quality properties were measured in the field, and each sample was collected and processed as described by Knapton (1985). Samples were analyzed for major ions, trace elements, and radon. Additionally, water-quality information was obtained from the IHS. Water-quality data in this report from IHS included only those analyses that balanced electrochemically to within 5 percent. Two analyses obtained from IHS for wells W77 and W151 reported the concentration of sodium plus potassium rather than separate concentrations for each. Because potassium is a component of the water-quality diagrams of analyses, values of 5 mg/L were abitrarily used for the potassium concentration and 5 mg/L was subtracted from the sodium concentration to keep the same value for the sodium plus potassium ionic concentration. Similarly, for the analysis of water from well W60, a concentration for magnesium was not reported; thus, a value of 0.5 mg/L was arbitrarily used for the magnesium concentration. For wells that had more than one analysis of water, only the most recent analysis was used in water-quality diagrams or statistical summaries.

Location and Site Numbering System

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. 2). The location number consists of as many as 14 characters. The first three characters specify the township and its position south (S) of the Montana Base Line. The next three characters specify the range and its position east (E) of the Montana Principal Meridian. The next two characters are the section number. The next three to four 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 or spring is located. These four subdivisions of the section are designated A, B, C, and D in a counter-clockwise direction, beginning in the northeastern quadrant. The last two characters specify a sequence number to distinguish between multiple wells in a single tract. For example, as shown in figure 2, well 01S34E17CDCC01 is the first well inventoried in the SW 1/4 (C) of the SW 1/4 (C) of the SE 1/4 (D) of the SW 1/4 (C) of sec. 17, T. 1 S., R. 34 E. For clarity in the report, ground-water sites also are assigned a site number from W1 to W193 (fig. 2, table 4).

Eight-digit station-identification numbers for established surface-water sites represent the standard USGS numbering system for streamflow-gaging stations. For clarity in this report, established surface-water sites, in addition to synoptic-streamflow sites, also are assigned a site number from S1 though S27 (pl. 1).

Acknowledgments

The author acknowledges with appreciation the many individuals who assisted in the study. Particular thanks are given to the well owners in the study area for allowing access to their wells. Appreciation also is extended to Mary Manydeeds and Robert Old Horn (BIA), for their field assistance and information about the study area; Connie Howe, Crow Environmental Protection Program (CEPP), for access to and information about the study area; Rex Harris and Bruce Fritzler (IHS), for access to drillers' logs and water-quality information; and DeAnn M. Dutton and Bruce M. Bochy (USGS), for their field assistance. Special thanks are given to Dave R. Johnson (USGS), for conducting the synoptic-streamflow investigation of the Little Bighorn River and for compilation, discussion, review, and interpretation of streamflow data.

GROUND-WATER RESOURCES

Hydrogeologic Setting

The study area is underlain by sedimentary rocks and deposits ranging in age from Mississippian to Quaternary (pl. 1). Rocks that range in age from Mississippian through Late Cretaceous consist of marine, near-shore, and coastal-plain deposits. These rocks were deposited primarily in broad, shallow seas or near-shore environments extending across most of what is now the State of Montana. Regional tectonic activity produced uplifts that interrupted marine and near-shore deposition, eroded pre-existing rocks, and caused coastal-plain sediments to be deposited. Rocks that are Tertiary in age consist of the Paleocene Tullock Member of the Fort Union Formation. These rocks were deposited in a large structural basin that formed as a result of intermittent crustal movements throughout Late Cretaceous and Tertiary time. The area became a depositional center for locally derived sediment in fluvial and lacustrine depositional environments (Flores and Ethridge, 1985). By late Miocene to early Pliocene time, renewed faulting uplifted the area, and rivers and streams eroded some pre-existing Tertiary deposits. By Pleistocene time, the Bighorn Mountains and adjacent areas were eroded to their general present-day configuration (Glaze and Keller, 1965). Pleistocene streams continued to deposit gravel, sand, silt, and clay across channels, flood plains, and terraces on the valley floors and valley margins. Extensive terraces formed along the western side of the present Little Bighorn River valley. Major tectonic activity was assumed to have ended in late Tertiary time, but the area probably was active periodically during the Quaternary (Agard, 1989). Deposits that are Quaternary in age consist of unconsolidated gravel, sand, silt, and clay.

A principal aquifer along the Little Bighorn River includes Quaternary alluvium of flood plains and low and high terraces. Quaternary low-terrace deposits underlie about 10 mi^2 and generally extend along the Little Bighorn River southwest of Wyola. Because alluvium and low-terrace deposits probably function as

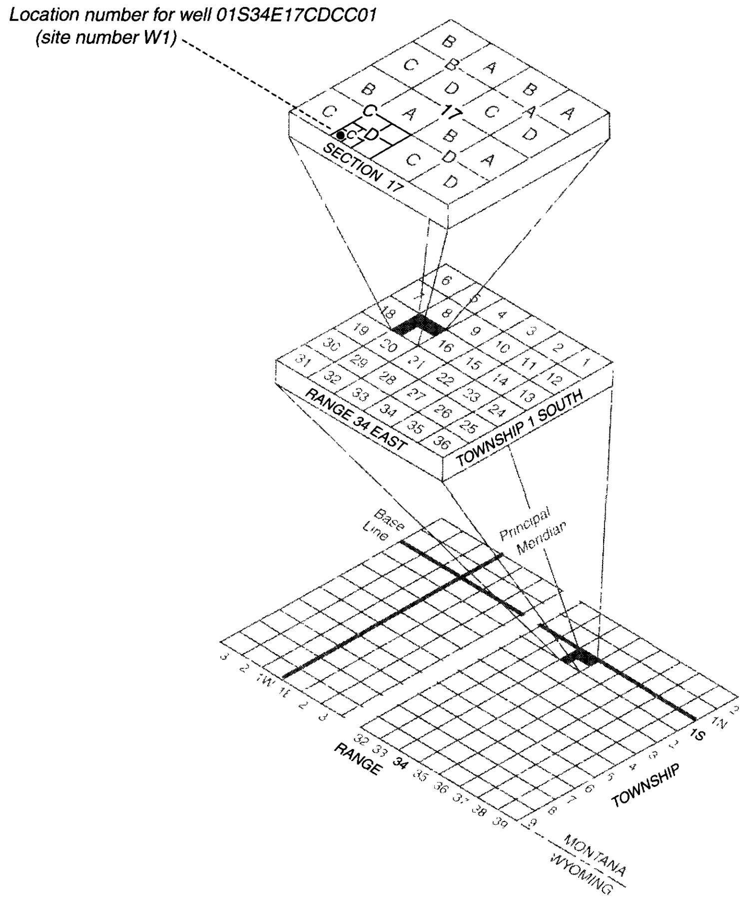


Figure 2. Numbering system for ground-water sites.

one hydrogeologic unit, these two deposits are hereinafter called Quaternary alluvium. The Upper Cretaceous Judith River Formation also is an important aquifer. Other aquifers in the area include the Tertiary Tullock Member of the Fort Union Formation, Upper Cretaceous Hell Creek Formation and Fox Hills Sandstone, and sandy hydrogeologic units in the Upper Cretaceous Bearpaw Shale (pl. 1). The general hydrogeologic setting of the study area consists of unconsolidated gravel, sand, silt, and clay deposits having moderate-to-low permeability underlain by fine-grained sandstone and shale generally having a lower permeability. Thickness and extent of both the alluvium and the Judith River Formation vary throughout the study area. The availability of water from these hydrogeologic units depends on aquifer thickness, extent of interstitial or interbedded silt and clay, and amount of recharge from the Little Bighorn River, Lodge Grass Creek, irrigation, or other hydrogeologic units. Quaternary alluvium and the Judith River Formation are discussed in detail because most water supplies originate from these two aquifers and because data are insufficient to describe other aquifers.

Quaternary Alluvium

Quaternary alluvium underlies an area of about 94 mi^2 located primarily along the Little Bighorn River and its perennial tributaries, Lodge Grass and Pass Creeks, and large ephemeral tributaries, Owl and Reno Creeks. Quaternary alluvium is composed of unconsolidated gravel, sand, silt, and clay and generally is less than about 30 ft thick. Thickness of the probable water-bearing zone within alluvium ranges from 2 to 39 ft, with a median of 9 ft. Many of the drillers' logs reported a thickness between about 5 and 13 ft.

On the basis of information from Moulder and others (1960) and information from drillers' logs about static-water levels and top of the probable water-bearing zone near wells, water in alluvium in the study area can be confined, unconfined, or leaky-confined. In most areas along the Little Bighorn River, several feet of fine-grained sediment overlies the coarse-grained sediments that form the water-bearing zone in alluvium. Thus, the fine-grained sediment forms a confining or leaky-confining layer, which can restrict direct recharge from nearby surface-water sources. Except where sandstone within the Judith River Formation underlies alluvium, several thousand feet of fine-grained, low permeability sandstone and shale of Upper and Lower Cretaceous rocks form a basal layer.

Aquifer tests conducted at two wells completed in Quaternary alluvium as part of an earlier investigation (Moulder and others, 1960)[1] yielded estimates of hydraulic conductivity of about 130 and 210 ft/d, transmissivity of 2,000 and 4,000 ft^2/d, and storage coefficients that ranged from about $2.8x10^{-7}$ to $2.6x10^{-3}$. In this study, the specific capacity of wells (table 6) completed in Quaternary alluvium ranged from 0.31 to 30 (gal/min)/ft, with a median of 2.8 (gal/min)/ft. Transmissivity estimates from specific-capacity tests ranged from 230 to 6,900 ft^2/d, with a median of 810 ft^2/d and an average of about 1,400 ft^2/d. Reported well yields from Quaternary alluvium ranged from 4 to 50 gal/min, with a median of about 15 gal/min. After pumping at relatively low rates (generally less than about 13 gal/min), water levels in many wells fell below the top of the water-bearing zone, resulting in unconfined conditions at the well. Low hydraulic conductivity and transmissivity, low specific capacity, and low well yield are typical of alluvium deposited by rivers having a small carrying and sorting capacity, which results in deposits containing substantial quantities of fine-grained material. In addition, these deposits might also contain discontinuous or poorly connected lenses of coarse-grained material.

The direction of water movement in Quaternary alluvium can be determined from the potentiometric surface shown in plate 1. Water in the aquifer moves at right angles to the contours and downgradient. In the study area, the direction of water flow generally is from the valley margins, where alluvium is recharged, toward the Little Bighorn River, where water from these deposits discharges to the river. The gradient of the potentiometric surface varies. South of Wyola near the valley margins, the gradient is steep and is about 0.02 (100 ft/mi), but decreases to 0.002 (10 ft/mi) along the river. The gradient near Benteen is 0.003 (18 ft/mi), and north of Crow Agency the gradient is 0.004 (22 ft/mi).

Recharge

Estimates of recharge and discharge components (developed as part of this study) for the Quaternary alluvium are summarized in table 1. Because of the large areal extent of Quaternary alluvium, the ground- and surface-water interactions, and the complexity of the irrigation systems in the study area, accurately determining most of the components of recharge and discharge is beyond the scope of this study. Therefore, these components are discussed only qualitatively. No attempt was made to balance recharge and discharge components in a hydrologic budget. However, recharge and discharge estimates could be used as a conceptual model for water flow in the Quaternary alluvium.

Recharge to Quaternary alluvium is by infiltration and subsequent percolation of precipitation, canal leakage, excess applied irrigation water, bank storage, and by subsurface inflow from alluvium in small ephemeral tributaries adjacent to the Little Bighorn valley (Moulder and others, 1960) and from the underlying Upper Cretaceous Judith River Formation. Infiltration and subsequent percolation of precipitation typically recharge the alluvium during the fall and winter before the ground freezes, and early spring when evapotranspiration is minimal. Average precipitation (fig. 3) in the study area from October through April is 6.7 in. (Western Regional Climate Center, 2001); therefore, recharge from precipitation during this period cannot be more than about 33,700 acre-ft/yr. Actual recharge from precipitation probably is substantially less than this quantity because some of this precipitation will sublimate, evaporate, run off, transpire, or be retained as soil moisture. Water-level rises in some

[1]Moulder and others (1960) acknowledged that aquifer-test results were erratic and might be somewhat in error. However, the values appeared to be valid for this type of aquifer.

Table 1. Estimates of recharge and discharge components for Quaternary alluvium and the Upper Cretaceous Judith River Formation along the Little Bighorn River and adjacent areas, Montana

[Abbreviations: acre-ft/yr, acre-foot per year; ft^3/s, cubic foot per second. Symbols: <, quantity less than this value; <<, quantity substantially less than this value; >, quantity greater than this value; --, not determined]

Component	Estimated quantity or range	
	(acre-ft/yr)	(ft^3/s)
Recharge to Quaternary alluvium		
Infiltration of precipitation	<<33,700	<<47
Canal leakage and excess irrigation water	--	--
Bank storage	--	--
Inflow from ephemeral tributaries	--	--
Inflow from the Judith River Formation	175 to 1,750	.24 to 2.4
Discharge from Quaternary alluvium		
Evapotranspiration	--	--
Withdrawals from wells	>130	>.02
Outflow to drains	--	--
Outflow to the Little Bighorn River determined from baseflow calculations from streamflow-gage records (water years 1953-55; 1982-94)	32,600	45
Outflow to the Little Bighorn River determined from low-flow investigation (October 1994)	<39,800	<55
Recharge to Upper Cretaceous Judith River Formation		
Infiltration of precipitation	<<26,900	<<37
Canal leakage	--	--
Bank storage	--	--
Discharge from Upper Cretaceous Judith River Formation		
Outflow to Quaternary alluvium	175 to 1,750	.24 to 2.4
Withdrawals from wells	<130	<.08
Evapotranspiration	--	--

wells during the fall, winter, and spring (when recharge can be greater than discharge) probably result from a combination of infiltration of precipitation before the ground freezes or after it thaws, canal leakage where water is maintained in canals for stock use, subsurface inflow from alluvium in small ephemeral tributaries, or subsurface inflow from the Judith River Formation (fig. 4, for example, wells W13, W22, W26, W125, W131, W152, W163, and W174). Generally, precipitation probably does not substantially recharge alluvium from May through September because evapotranspiration by crops and natural vegetation typically exceeds precipitation in the study area during the growing season in most years (Moulder and others, 1960; Toy and Munson, 1978). Above-normal precipitation during some months in 1995 (fig. 3) in the study area (Western Regional Climate Center, 2001) probably caused water levels in some wells, in part, to increase in May and June 1995. Water levels in some wells completed in alluvium decreased generally from June through September, 1995 (fig. 4; for example, wells W13, W22, W131, W144, W152, W174); thus, recharge generally is assumed to be less than discharge during this time.

The quantity of recharge to Quaternary alluvium by canal leakage and infiltration of water applied to irrigated fields is unknown but could be large. Moulder and others (1960) estimated an average leakage rate of 0.00038 ft^3/s per foot of canal length, based on a determination that canal leakage along the Agency Canal in

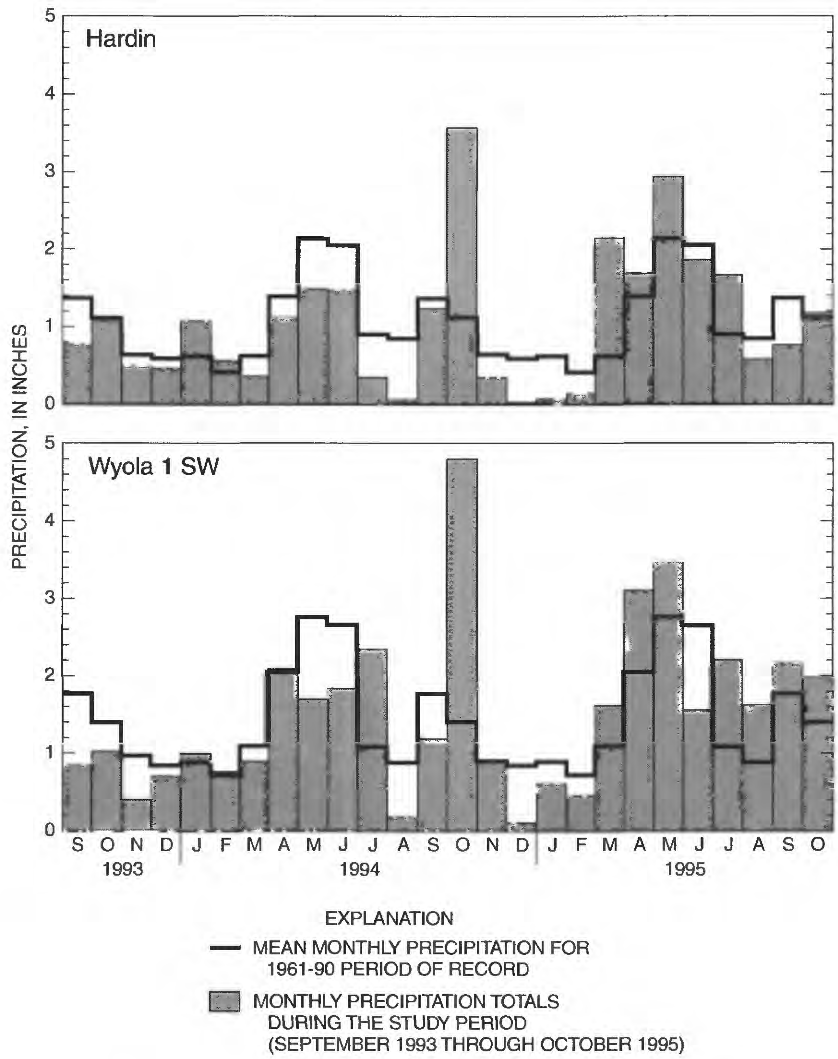


Figure 3. Mean monthly precipitation for the 1961-90 period of record and monthly precipitation totals for the study period at Hardin and near Wyola, Montana. Data from the Western Regional Climate Center (2001).

sec. 1, T. 3 S., R. 34 E., ranged from 100 to 400 gallons per day per foot of canal length. The volume of water released to the canal systems in the study area is unknown. Some streamflow from Lodge Grass Creek is stored in the Lodge Grass Storage Reservoir (about 23,000 acre feet) and then released to the Lodge Grass Canal No. 1; unused water in the canal flows to the Little Bighorn River (U.S. Geological Survey, 1996). Applied irrigation water only recharges the aquifer when the volume of applied water plus precipitation exceeds evapotranspiration. Information about the volume of irrigation water applied to fields also is unavailable.

The quantity of recharge to Quaternary alluvium by infiltration of bank storage during high streamflow is unknown. Figure 5 shows water-level rises due to the effects, in part, of bank storage in wells W26, W125, W163, and W184. Water levels in these wells generally increased during sustained streamflow peaks of the Little Bighorn River and then decreased as streamflow decreased.

The quantity of recharge to Quaternary alluvium by subsurface inflow from alluvium in small ephemeral and intermittent tributaries also is unknown. Ephemeral and intermittent streams likely provide recharge during intense or abundant rainfall and runoff as water infiltrates into alluvial deposits and alluvial fans that

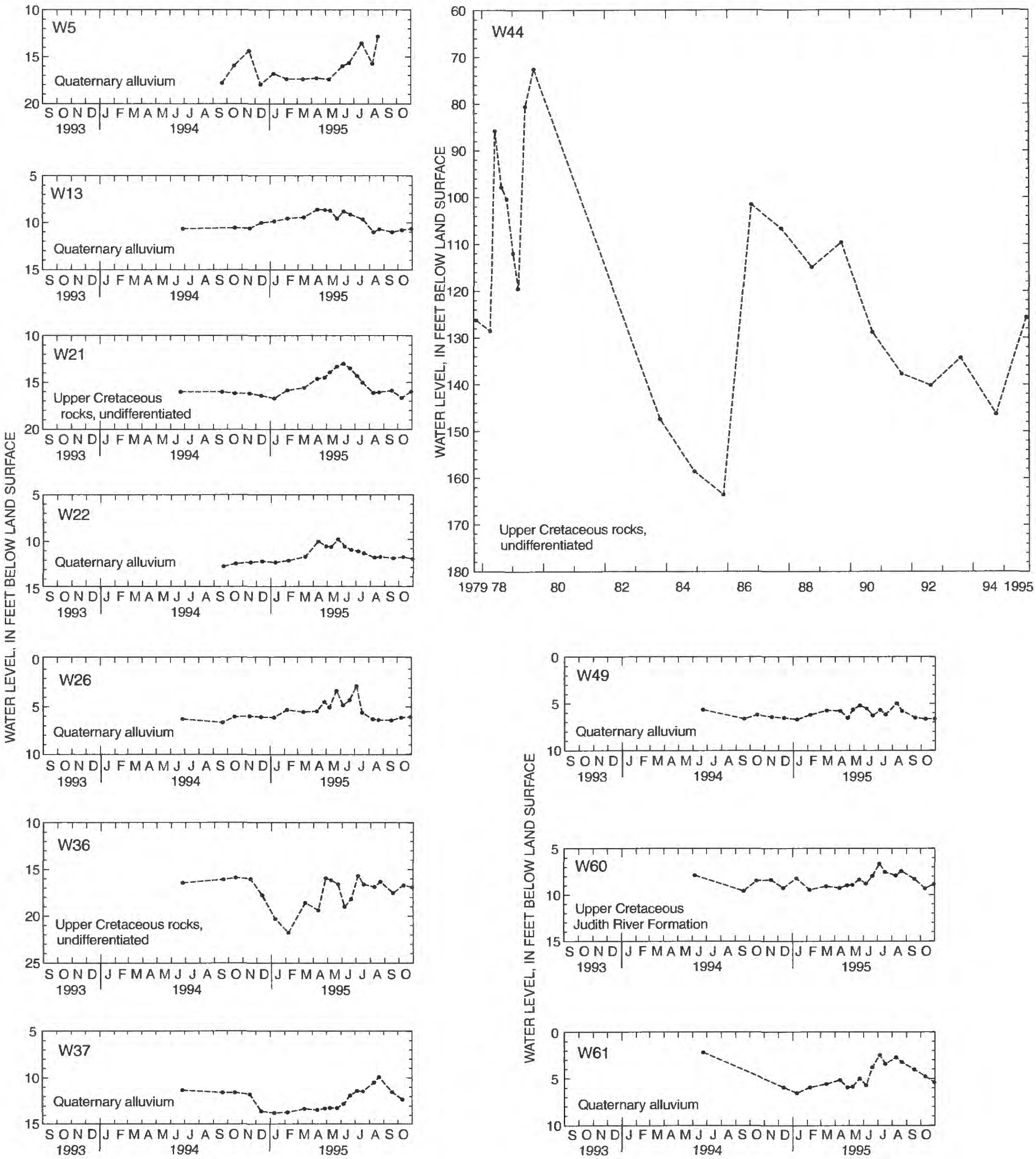


Figure 4. Hydrographs of water levels in selected wells along the Little Bighorn River and adjacent areas, Montana.

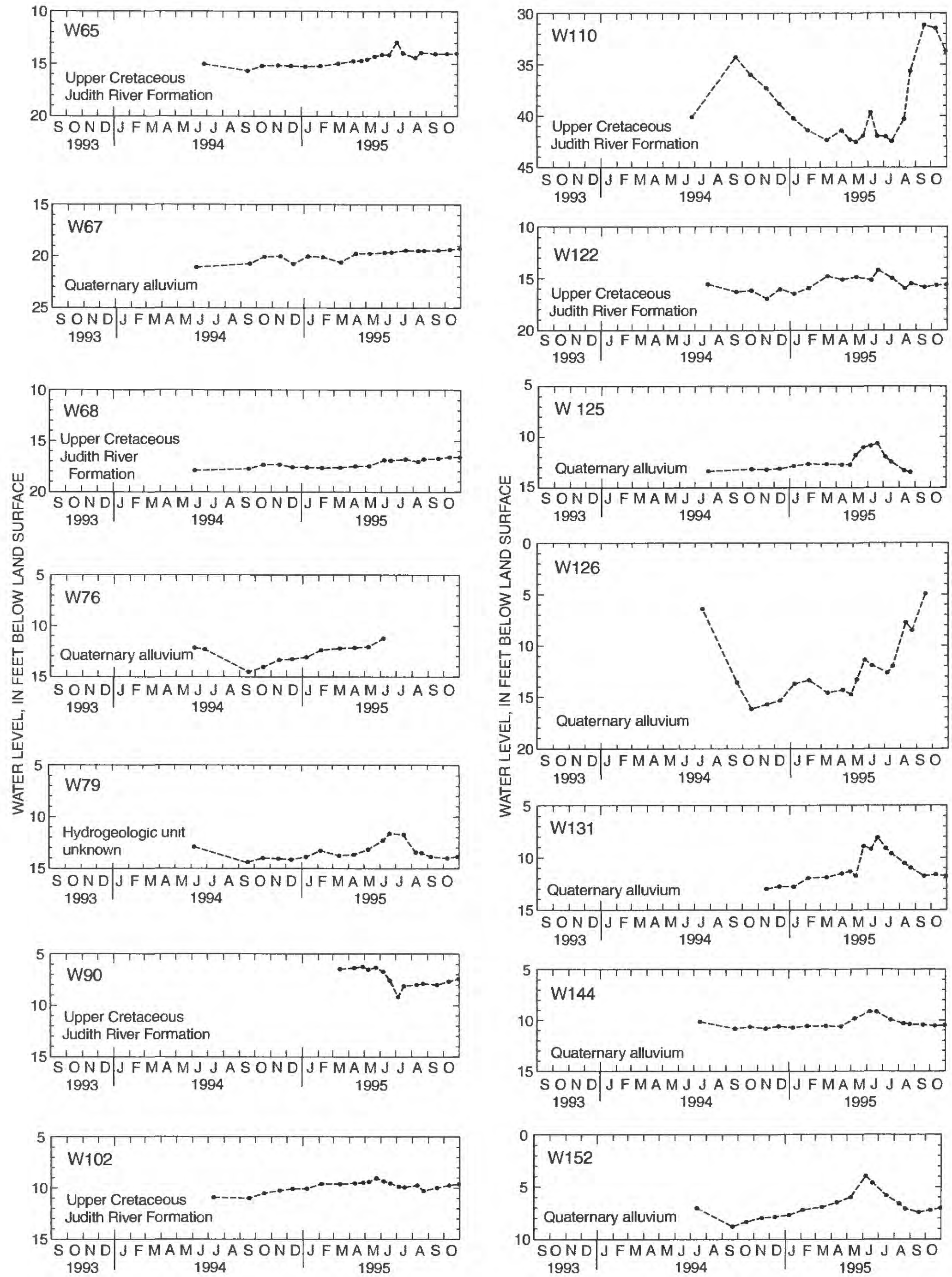


Figure 4. Hydrographs of water levels in selected wells along the Little Bighorn River and adjacent areas, Montana (Continued).

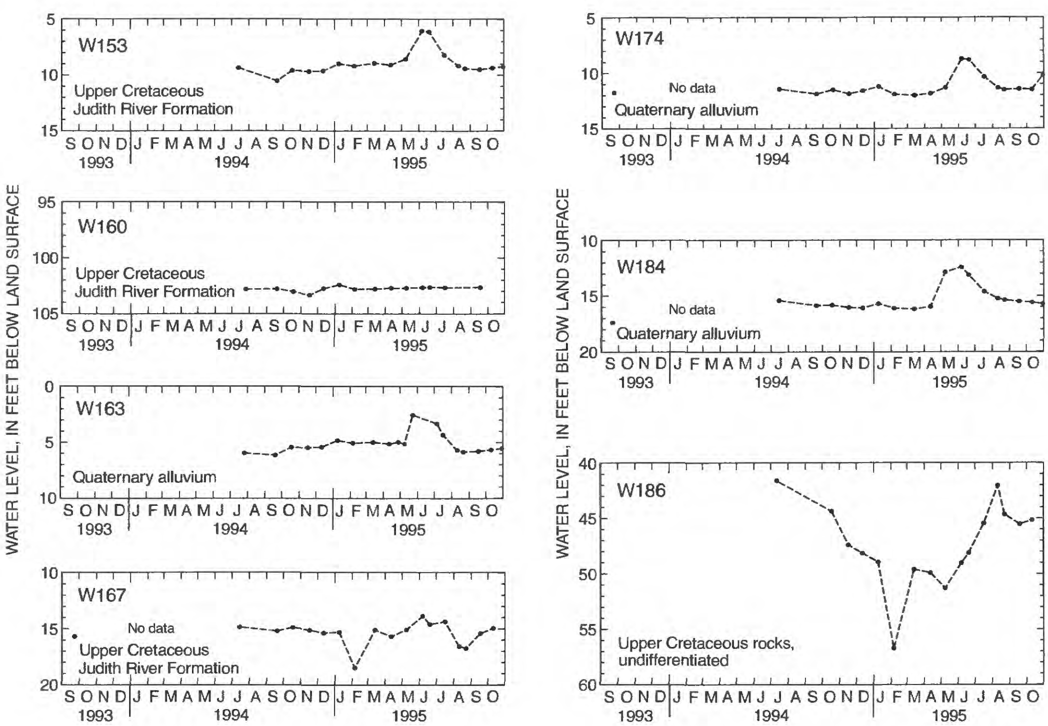


Figure 4. Hydrographs of water levels in selected wells along the Little Bighorn River and adjacent areas, Montana (Continued).

flank the Little Bighorn River valley. Because many ephemeral and intermittent streams do not have well-defined channels, some surface runoff might seep into the ground. This type of recharge might occur where the altitude of the ground-water table is below the altitude of the ephemeral or intermittent stream channel. Along Shoulder Blade Creek, water-level altitudes in wells W66, W67, W68, W69 and nearby altitudes of the stream channel indicate that this creek could lose water to the subsurface, recharging the alluvium and Judith River Formation. For the period of study, water levels in well W67, which is completed in the alluvium along Shoulder Blade Creek (pl. 1, fig. 4), showed an overall increasing trend in response to above-normal precipitation during some months in 1995. Ground water in the alluvium along Shoulder Blade Creek most likely flowed towards the Little Bighorn valley and eventually recharged the alluvium along the Little Bighorn River. Similar ground-water flow conditions likely occur along other ephemeral and intermittent tributaries of the Little Bighorn River.

Recharge to Quaternary alluvium by ground-water flowing from the underlying Judith River Formation is indicated by an upward component of flow in the Judith River Formation. Water levels in some wells completed in the Judith River Formation can be higher than water levels in wells completed in the alluvium, indicating that ground water is flowing upward from the Judith River Formation to recharge the Quaternary alluvium.

The amount of ground water flowing from the Judith River Formation into the alluvium can be calculated using the Darcy equation:

$$Q = KIA \times 365 \text{ days per year} \qquad (3)$$

where:

Q = ground-water flow from the Judith River Formation, in acre-feet per year;

K = hydraulic conductivity, in feet per day;

I = hydraulic gradient, dimensionless; and

A = cross-sectional area of the Judith River Formation, in acres.

Recharge to Quaternary alluvium from the underlying Judith River Formation is estimated to range from about 175 to 1,750-acre-ft/yr based on an

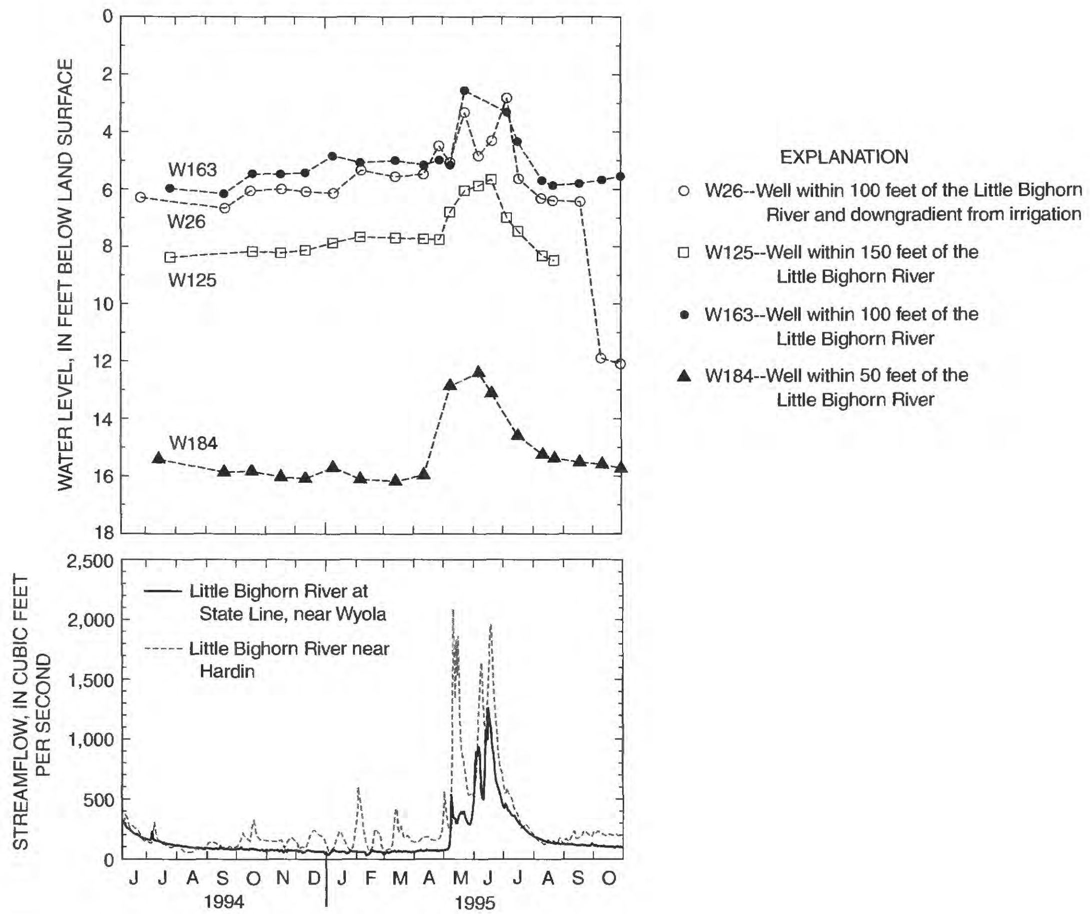


Figure 5. Seasonal variation in water levels in wells completed in Quaternary alluvium and comparison to streamflow of the Little Bighorn River, Montana.

areal extent of about 24,960 acres (39 mi^2) where the Judith River Formation underlies alluvium, a vertical hydraulic gradient of 0.07 (determined from wells W47 and W48), and vertical hydraulic conductivities that range from 0.1 to 1.0 ft/d. This estimate also is based on the assumption that vertical gradients are the same throughout the study area and that the vertical hydraulic conductivity is about an order of magnitude less than the horizontal hydraulic conductivity (about 8 and 50 ft/d; Moulder and others, 1960). However, vertical gradients and vertical hydraulic conductivities probably vary throughout the study area.

Discharge

Discharge from Quaternary alluvium is primarily through evapotranspiration, withdrawals from wells, flow to irrigation drains, and subsurface outflow to the Little Bighorn River. Alfalfa and pasture grasses are cultivated for hay crops on most alluvium. Although most water needs by alfalfa and pasture grasses probably were met by sprinkler and flood irrigation (from surface-water sources) and precipitation during the 1995 growing season, diurnal ground-water-level fluctuations can indicate discharge by evapotranspiration, particularly during warm summer days when the water needs of crops can be substantial (Dollhopf and others, 1979). The quantity of discharge from the alluvium by evapotranspiration is unknown. Moulder and others (1960) documented the effects of evapotranspiration on water-level fluctuations in some wells completed in the alluvium along the Little Bighorn River and concluded daily water-level fluctuations were the result of evapotranspiration during the growing season. Additionally, they concluded that from mid-July through September, recharge could exceed discharge or discharge could exceed recharge, depending on variations in evapotranspiration rate, canal stage, and amount of precipitation. Some water levels in wells completed in the alluvium decreased during June through September 1995 reflecting a decrease in ground-water storage concurrent with the irrigation season (wells W22, W49, and W144; fig. 4). Thus, discharge exceeded recharge during this period. For the 1995 growing period, this decrease in water levels represents a decrease in storage that probably is at least in part due to evapotranspiration.

Water in the Quaternary alluvium is primarily used for either domestic or stock-watering purposes. Water from alluvium is not used for irrigation. Water withdrawn from wells for domestic use in the entire study area was estimated to be about 260 acre-ft/yr. This quantity was estimated on the basis of a statewide average withdrawal rate of 78 gal/d per person (Montana Department of Natural Resources and Conservation, 1986) and an estimated population of about 3,000 people (approximate population of the eastern one-half of Big Horn County living outside of the Towns of Lodge Grass and Crow Agency, 2000 census data; Montana Department of Commerce, 2002). This estimate assumes that most people living in the eastern one-half of Big Horn County live along the Little Bighorn River and use water from either the Quaternary alluvium or the Judith River Formation. Quaternary alluvium underlies 94 mi^2 of the study area and the Judith River Formation underlies about 39 mi^2 of alluvium. Because the alluvium is shallower than the Judith River Formation, it is likely that at least one-half of the 260 acre-ft/yr is withdrawn from the alluvium (table 1). Withdrawals from wells for stock-watering purposes is unknown but is assumed to be small because surface water from the river and canals is used extensively for stock watering along the alluvial valley.

The quantity of discharge from Quaternary alluvium to irrigation drains is unknown, but might be large. Moulder and others (1960) determined that for many areas from Lodge Grass to the confluence of the Little Bighorn and Bighorn Rivers the high water table during the irrigation season caused extensive waterlogging. Irrigation drains reduced waterlogging in some areas by providing a surface conduit to discharge excess near-surface ground water.

Discharge from the Quaternary alluvium by subsurface outflow to the Little Bighorn River was not measured directly, but can be inferred from historical base-flow conditions and a 1994 synoptic-streamflow investigation of the Little Bighorn River. Discharge from the alluvium during base-flow conditions (generally November through February) for the period of concurrent record, 1953-55 and 1982-94, can be inferred from long-term streamflow records from sites S2, S4, S7, S25, and S27 (fig. 6, pl. 1). The long-term mean-monthly streamflow (average of the monthly mean streamflow values for each year of record) at sites S2 and S4 (Little Bighorn River and Pass Creek) was added and then the total was subtracted from the long-term mean-monthly streamflow at site S7 (Little Bighorn River below Pass Creek). Likewise, the long-term mean-monthly streamflow at sites S7 and S27 (Lodge Grass Creek) was added and then the total was subtracted from the long-term mean-monthly streamflow at site S25 (near the mouth of the Little Bighorn River). Using the flow at site S27 assumes that the long-term mean-monthly streamflow at site S27 was the same as at site S13 near the mouth of Lodge Grass Creek. The difference in streamflow between sites S27 and S13 on Lodge Grass Creek is not known, but presumably is minor during base-flow conditions.

The difference in the long-term mean-monthly streamflow along the upper Little Bighorn River and Pass Creek above site S7 (fig. 6) ranged from about 18 to 23 ft^3/s and averaged 20 ft^3/s (table 2). Thus, discharge from the alluvium is equivalent to about 13,000 to 16,700 acre-ft/yr, assuming the discharge rate throughout the year is the same as that during the November through February base-flow period. On the basis of this estimated range, about 0.79 to 1.0 ft^3/s of water per mile discharges primarily from the alluvium along the 23-mile upper reach of the Little Bighorn River valley.

The difference in the long-term mean-monthly streamflow along the lower Little Bighorn River for the same 4 months from site S7 to S25 (fig. 6) ranged from about 11 to 55 ft^3/s (average of 24 ft^3/s, table 2), which is equivalent to about 8,000 to 39,800 acre-ft/yr. On the basis of this estimated range, about 0.26 to 1.3 ft^3/s of water per mile discharges primarily from the alluvium along the 44-mile lower reach of the Little Bighorn River. Thus, the long-term mean-monthly gain in flow for the entire 67 miles of the Little Bighorn River valley from site S2 to S25 ranged from about 35 to 73 ft^3/s and averaged 45 ft^3/s (equivalent to 32,600 acre-ft/yr).

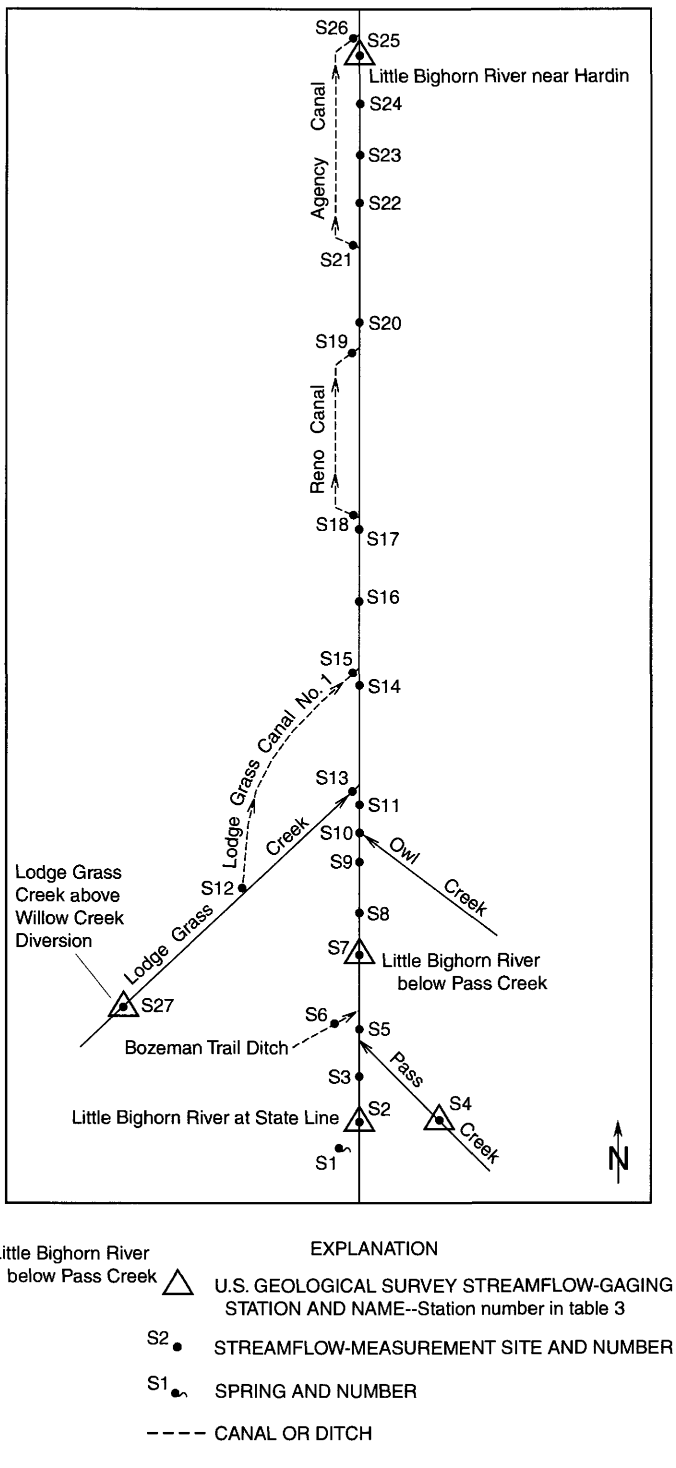


Figure 6. Synoptic-streamflow measurement sites along the Little Bighorn River, Montana.

Table 2. Gains in streamflow calculated from concurrent streamflow-gage records during base flow for the Little Bighorn River, Pass Creek, and Lodge Grass Creek, Montana

[Site numbers described in text. Figure 6 shows schematic diagram of streamflow-gaging sites. Streamflow data are for the concurrent period of record, water years 1953-55 and 1982-94. Streamflow gains in the upper Little Bighorn River valley are represented by values shown for site S7; gains in the lower Little Bighorn River valley are represented by values shown for site S25. Difference in streamflow, for the entire period of record indicated for the month, is the mean monthly: for site S7—the combined long-term mean-monthly streamflow for sites S2 plus S4, subtracted from the concurrent long-term mean-monthly streamflow at site S7; for site S25—the combined long-term mean-monthly streamflow for S7 plus S27 subtracted from the concurrent long-term mean-monthly streamflow at site S25. Linear valley distance along the upper Little Bighorn River and Pass Creek (sites S2 and S4) to the upper Little Bighorn River at site S7 is about 23 miles. Linear valley distance along the lower Little Bighorn River from site S7 to site S25 is about 44 miles. Abbreviations: ft^3/s, cubic feet per second; LBHR, Little Bighorn River. Symbol: --, not determined]

Abbreviated streamflow-gaging station name	Site number	Long-term mean-monthly streamflow	Difference in long-term mean-monthly streamflow (ft^3/s)	Gain in streamflow per mile (ft^3/s)
		November		
LBHR at State Line	S2	67.0	--	--
Pass Creek	S4	16.6	--	--
LBHR below Pass Creek	S7	105	21.4	0.93
LBHR near Hardin	S25	136	14.0	.32
Lodge Grass Creek	S27	17.0	--	--
		December		
LBHR at State Line	S2	61.0	--	--
Pass Creek	S4	15.3	--	--
LBHR below Pass Creek	S7	95.0	18.7	.81
LBHR near Hardin	S27	127	16.6	.38
Lodge Grass Creek	S25	15.4	--	--
		January		
LBHR at State Line	S2	58.0	--	--
Pass Creek	S4	18.8	--	--
LBHR below Pass Creek	S7	100	23.2	1.0
LBHR near Hardin	S25	127	11.4	.26
Lodge Grass Creek	S27	15.6	--	--
		February		
LBHR at State Line	S2	55.0	--	--
Pass Creek	S4	26.9	--	--
LBHR below Pass Creek	S7	100	18.1	.79
LBHR near Hardin	S25	171	55.1	1.3
Lodge Grass Creek	S27	15.9	--	--

Gains in streamflow from the Judith River Formation also are possible because this formation crops out along the river from near Wyola to Benteen. However, gains in streamflow from the Judith River Formation would not be determined from available streamflow data.

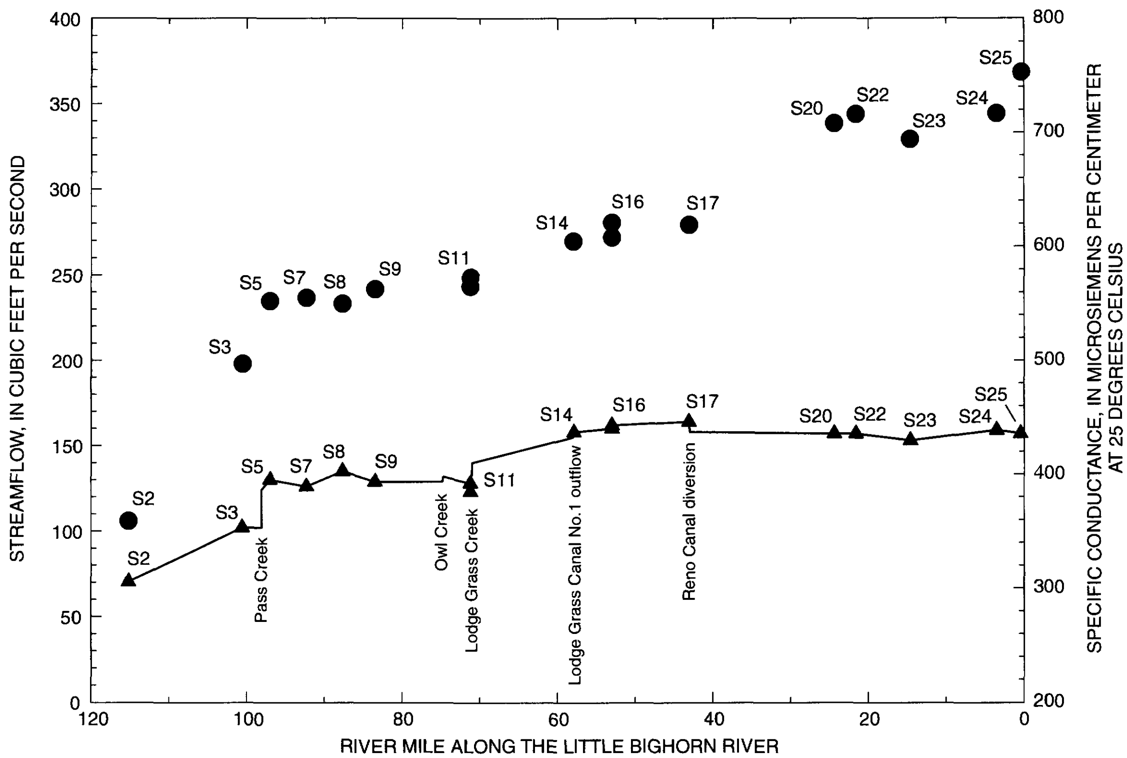
Discharge from Quaternary alluvium also can be inferred from synoptic-streamflow measurements made during base-flow conditions along the Little Bighorn River. A synoptic-streamflow investigation was conducted on October 25, 1994 (figs. 6 and 7, table 3), to spatially delineate and quantify gains in streamflow during a period absent of precipitation runoff and minimally affected by evapotranspiration. Gains or losses of about 5 percent or less of the measured streamflow were not considered to necessarily represent flow changes because this range of variability is within the typical error range for measurement precision. Also, diurnal variation may have caused flow changes of this magnitude. Two sites where replicate streamflow measurements were made (S11 and S16, table 3) indicated measurement differences of about 1 to 4 percent.

Gains in streamflow from sources other than tributaries were notable for two reaches along the Little Bighorn River (figs. 6 and 7, table 3). First, from sites S2 to S5, streamflow increased by about 38 ft^3/s, after subtracting tributary inflow from Pass Creek (site S4). Some of this increase might be attributed to unmeasured tributary inflow above Black Gulch and unmeasured irrigation return flow. In addition, some of this increase can be attributed to ground-water discharge from the Judith River Formation where it crops out between sites S3 and S7, and from older rocks where they crop out between S2 and Sport Creek. Thus, the quantity of ground water discharged from Quaternary alluvium between sites S2 and S5 is difficult to calculate from these synoptic measurements, but was less than 38 ft^3/s (less than 2.7 ft^3/s of water per mile) in

Table 3. Synoptic-streamflow and specific-conductance measurements along the Little Bighorn River, Montana, October 25, 1994

[Site numbers described in text. Remarks: S, USGS streamflow-gaging station and number; O, overlap site where same site was measured by two different teams. Abbreviations: ft^3/s, cubic feet per second; µS/cm, microsiemens per centimeter at 25 degrees Celsius. Symbols: --, no data or not applicable; ( ), number in parentheses denotes a decrease in streamflow]

River, creek, irrigation supply, or spring	Site number	Discharge (ft^3/s)	Difference in mainstem streamflow, minus tributaries (ft^3/s)	Specific conductance (µS/cm)	Remarks
Dripping Vat Spring	S1	0.05	--	2,680	--
Little Bighorn River	S2	70	--	359	S, 06289000
Little Bighorn River	S3	102	32	497	S, 06289500
Pass Creek	S4	22	--	590	S, 06290000
Little Bighorn River	S5	130	6	552	--
Bozeman Trail Ditch	S6	.2	--	--	--
Little Bighorn River	S7	126	(4)	555	S, 06290500
Little Bighorn River	S8	135	9	550	--
Little Bighorn River	S9	129	(6)	563	--
Owl Creek	S10	3.0	--	840	--
Little Bighorn River	S11	128	(4)	573	O
Little Bighorn River	S11	123	--	565	O
Lodge Grass Canal No. 1	S12	10	--	630	--
Lodge Grass Creek	S13	17	--	778	--
Little Bighorn River	S14	155	15	605	--
Lodge Grass Canal No. 1	S15	3.3	--	690	--
Little Bighorn River	S16	160	2	608	O
Little Bighorn River	S16	162	--	621	O
Little Bighorn River	S17	164	2	619	--
Reno Canal	S18	6.2	--	619	--
Reno Canal	S19	2	--	796	--
Little Bighorn River	S20	157	(3)	708	--
Agency Canal	S21	.1	--	678	--
Little Bighorn River	S22	157	0	716	--
Little Bighorn River	S23	153	(4)	694	--
Little Bighorn River	S24	159	6	717	--
Little Bighorn River	S25	157	(2)	753	S, 06294000
Agency Canal	S26	1.3	--	1,900	--



EXPLANATION

S17▲ STREAMFLOW AND SITE NUMBER--Tributary inflows from Pass Creek (site S4), Owl Creek (site S10), and Lodge Grass Creek (site S13) are added to mainstem streamflow of the Little Bighorn River. Lodge Grass Canal No. 1 outflow (site S15) is added to mainstem streamflow of the Little Bighorn River. Reno Canal diversion (site S18) is subtracted from mainstem streamflow and outflow (site S19) is added to mainstem streamflow of the Little Bighorn River (site S20)

S11 ● SPECIFIC CONDUCTANCE AND SITE NUMBER

Figure 7. Synoptic-streamflow measurements and specific conductance of the Little Bighorn River, Montana, October 25, 1994.

October 1994. Second, from sites S11 to S16, streamflow increased by about 17 ft^3/s, after subtracting tributary inflow from Lodge Grass Creek (site S13) and outflow from Lodge Grass Canal No. 1 (site S15). Some increase in streamflow likely can be attributed to unmeasured irrigation return flow. In addition, some increase in streamflow probably can be attributed to discharge from the Judith River Formation, but the extent of the contribution could not be determined from available data. Thus, the quantity of water discharged from Quaternary alluvium and the Judith River Formation between sites S11 and S16 was less than 17 ft^3/s (less than 3.0 ft^3/s of water per mile) in October 1994.

Other reaches of the Little Bighorn River did not show substantial gains in streamflow from ground water. In addition, no reach showed any substantial loss of streamflow that might indicate recharge to the alluvium. Specific conductance generally increased gradually in a downstream direction.

Apparent small gains in streamflow at some mainstem sites were followed by apparent small losses at downstream sites. These apparent small gains or losses from site to site might represent measurement errors or changes in flow over time (unsteady flow) as a result of diurnal streamflow fluctuations. Streamflow records on the dates of the synoptic-streamflow measurements indicate that streamflow may have fluctuated over the time of measurement by as much as 10 ft^3/s at sites S2, S7, and S25. As a result, mainstem streamflow changes less than about 10 ft^3/s may not represent gains or losses due to inflow or outflow, but rather changes due to unsteady flow conditions over the measurement period.

Overall, the synoptic measurements indicate an appreciable gain in streamflow between sites S2 and S5, no appreciable gain or loss between sites S5 and S11, an appreciable gain between sites S11 and S16, and no appreciable gain or loss between sites S16 and S25. The total gain, excluding surface-water inflows, indicated by the synoptic measurements was about 55 ft^3/s (39,800 acre-ft/yr). This figure compares favorably with the overall gain indicated by the comparison of long-term streamflow records at sites S2, S4, S7, S25, and S27 of 45 ft^3/s.

On the basis of the base-flow calculations from gage records (table 2) and the synoptic-streamflow investigation (table 3), gains in streamflow from ground water along the Little Bighorn River valley from site S2 to site S25 probably range from about 45 to 55 ft^3/s. Thus, ground water was estimated to contribute from 15 to 18 percent of the annual daily mean streamflow (water year 1995) of the Little Bighorn River near Hardin (site S25; U.S. Geological Survey, 1996).

Indirect evidence indicates that the Quaternary alluvium and the underlying Judith River Formation are hydraulically connected. These hydrogeologic units seem to have similar hydraulic heads near Lodge Grass and near Garryowen and the Little Bighorn Battlefield National Monument (pl. 1). However, the potentiometric contours are not well defined because of a lack of water-level data.

Short-term changes in water levels in wells (fig. 8) also provide indirect evidence that the two aquifers are hydraulically connected in the area between Garryowen and the Little Bighorn Battlefield National Monument and are recharged, in part, by leakage from the Reno Canal. Figure 8 illustrates the similarity of seasonal variation in water levels in wells completed in the alluvium and the Judith River Formation. Water-level rises and declines are similar, indicating a hydraulic connection between the two aquifers.

Water Quality

Based on the laboratory analytical results for samples collected and from data compiled for this study, water in the Quaternary alluvium generally had relatively high concentrations of dissolved calcium, magnesium, sodium, bicarbonate, sulfate, chloride, and iron (pl. 1 and fig. 9). The major-ion composition was predominated by calcium, magnesium, and sodium cations, and bicarbonate and sulfate anions.

A distinctive characteristic of water from most alluvium was the generally high concentrations of dissolved solids (fig. 9), which commonly exceeded 1,000 mg/L. Dissolved-solids concentrations ranged from 264 to 4,770 mg/L, with a median of 1,450 mg/L (table 7). The dissolved-solids concentrations generally were highest north of Crow Agency and just south of Lodge Grass (pl. 1). North of Crow Agency, the concentrations of dissolved solids might be high, in part, because Upper Cretaceous rocks underlie alluvium in this part of the study area. Water from marine shale within Upper Cretaceous rocks or interstitial sediment from this shale in the alluvium probably affects the water quality in alluvium (Moulder and others, 1960). South of Lodge Grass, the concentrations of dissolved solids in wells W131, W132, and W134 might be high, in part, because interbedded marine shale of the Judith River Formation affects the water quality in alluvium, and ground water probably is not recharged by the Little Bighorn River or irrigation.

The dissolved-solids concentrations in water from wells completed in alluvium generally were lower (less than 1,000 mg/L) along Lodge Grass Creek and southwest of Wyola (pl. 1). Wells near the Little Bighorn River (wells W7, W13, W42, W46, and W59) also have water with lower dissolved-solids concentrations. The low dissolved-solids concentrations in water from these wells probably indicate the effect of recharge from less mineralized water from the Little Bighorn River (median dissolved-solids concentrations of 179 mg/L at site S2 and 350 mg/L at site S25)[2], Lodge Grass Creek (median specific conductance of 510 μS/cm)[2], or water from irrigation.

Water-quality data were compared to primary and secondary drinking-water regulations of the U.S. Environmental Protection Agency (EPA) (2000). National primary drinking-water regulations are established for chemical constituents which, if present in drinking water, can cause adverse human health effects. Either a maximum contaminant level (MCL)

[2]Data retrieved from the USGS National Water Information System (NWIS), water years 1993-95.

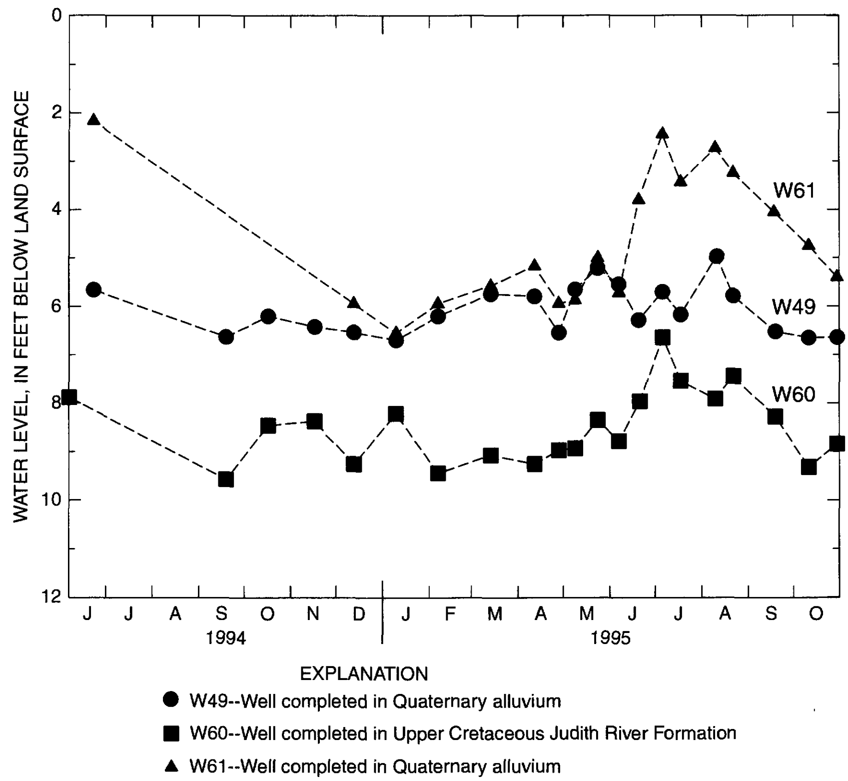


Figure 8. Seasonal variation in water levels in wells completed in Quaternary alluvium and the Upper Cretaceous Judith River Formation downgradient from the Reno Canal, Montana.

or a treatment technique is specified by these regulations. MCLs are health-based and enforceable for public drinking-water supplies. National secondary drinking-water regulations (SDWRs) are established for constituents or properties that can adversely affect the odor or appearance of water. These regulations are esthetically based and nonenforceable.

The chemical quality of water from the Quaternary alluvium (table 7) varied and, although widely used for domestic purposes, some water can pose a health risk for domestic use as defined by the EPA (2000) MCLs or was esthetically unsuitable as defined by the EPA SDWRs. Exceedances of the health-based MCLs were infrequent. The concentration of beryllium in water from three wells equaled or exceeded the MCL of 0.004 mg/L (4 µg/L) and the concentration of radon in water from 10 wells exceeded the MCL of 300 pCi/L. Exceedances of the esthetically based SDWRs were more common with the concentration of sulfate in water from 39 wells exceeding the SDWR of 250 mg/L and the concentration of dissolved solids in water from 39 wells exceeding the SDWR of 500 mg/L. The iron SDWR of 0.3 mg/L (300 µg/L) was equaled or exceeded in water from 14 wells, whereas the manganese SDWR of 0.05 mg/L (50 µg/L) was equaled or exceeded in water from 16 wells.

Water from alluvium might not be suitable for some irrigation applications based on a comparison of specific conductance and the sodium-adsorption ratio (U.S. Salinity Laboratory Staff, 1954). Generally, the water has a medium to very high salinity hazard (specific conductance that ranges from 431 to 5,080 µS/cm, table 4) and a low to very high sodium hazard (sodium-adsorption ratio that ranges from 0.5 to 26, table 7).

Upper Cretaceous Judith River Formation

The Upper Cretaceous Judith River Formation crops out generally west of the Little Bighorn River and, in the southern part of the study area, west of Pass Creek (pl. 1). The formation dips gently to the south-

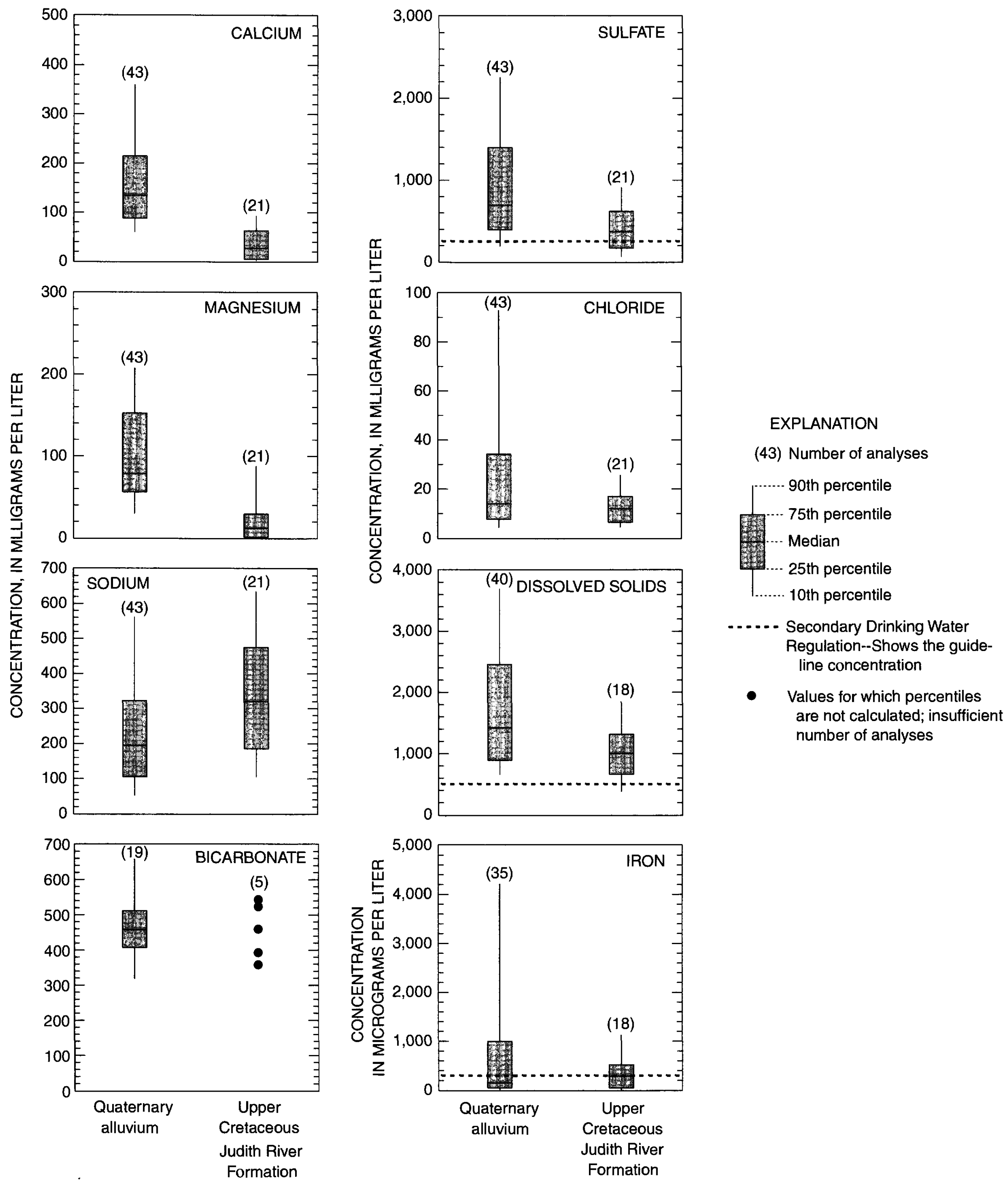


Figure 9. Distribution of concentrations for selected chemical constituents in water from Quaternary alluvium and the Upper Cretaceous Judith River Formation along the Little Bighorn River and adjacent areas, Montana. To emphasize the central tendency of data, the upper and lower 10 percent of data have been excluded to eliminate outliers.

east, east, and northeast owing to structural deformation associated with uplift of the Bighorn Mountains. Near the Montana-Wyoming boundary, the Judith River Formation includes an unnamed upper member composed of about 700 ft of sandstone interbedded with sandy shale and shale. The lower member, the Parkman Sandstone Member, is composed of as much as 350 ft of massive sandstone and sandy shale. Near Hardin, the Parkman Sandstone Member is 255 ft thick (Richards, 1955; Knechtel and Patterson, 1956).

On the basis of information from drillers' logs about static-water levels and top of the probable water-bearing zone in wells, water in the Judith River Formation can be confined, unconfined, or leaky-confined. In recharge areas, located mostly along the terraces west of the Little Bighorn River and Pass Creek, this hydrogeologic unit probably is unconfined. Along the Little Bighorn River valley and Pass Creek, the Judith River Formation underlies the alluvium, which probably forms a leaky-confining layer. Several thousand feet of fine-grained, generally low-permeable Upper Cretaceous sandstone and shale underlie the Judith River Formation.

Aquifer tests conducted at two wells completed in the Judith River Formation as part of a previous reconnaissance investigation (Moulder and others, 1960) yielded estimates of hydraulic conductivity of about 8 and 50 ft/d, transmissivity of 780 and 2,700 ft^2/d, and a storage coefficient of 0.0005. In this study, the specific capacity of wells (table 6) completed in the Judith River Formation ranged from 0.06 to 7.4 (gal/min)/ft, with a median of 0.41 (gal/min)/ft. Transmissivity estimates from specific-capacity tests ranged from 39 to 780 ft^2/d, with a median of 310 ft^2/d and an average of 350 ft^2/d. Reported well yields from the Judith River Formation ranged from 5 to 74 gal/min, with a median of about 10 gal/min. After pumping at relatively low rates (less than about 12 gal/min) water levels in many wells fall below the top of the water-bearing zone, resulting in unconfined conditions at the well (table 6). Low hydraulic conductivity and transmissivity, low specific capacities, and low well yields are typical of the Judith River Formation, where interbedded shale and fine-grained sandstone can be lenticularly bedded and laterally discontinuous (Richards, 1955; Knechtel and Patterson, 1956).

The direction of water movement in the Judith River Formation can be determined from the potentiometric surface shown in plate 1. The direction of water flow generally is from outcrop and subcrop areas west of the Little Bighorn River to the Little Bighorn River where water discharges to the Quaternary alluvium or the river. South of Wyola, water flows from outcrop and subcrop areas to the Little Bighorn River or Pass Creek, where the Judith River Formation might discharge to alluvium. The gradient of the potentiometric surface varies. Near Wyola, the gradient is about 0.006 (33 ft/mi). Near Lodge Grass, the gradient is steep near the recharge area northwest of Lodge Grass and is 0.02 (120 ft/mi), but decreases near the river to 0.004 (21 ft/mi). West of Reno Creek, the gradient is steep and is about 0.02 (80 ft/mi), but decreases to about 0.005 (29 ft/mi) along the river near the Little Bighorn Battlefield National Monument.

Recharge

Estimates of recharge and discharge components (developed as part of this study) for the Judith River Formation are summarized in table 1. Because of the large areal extent of the Judith River Formation, the ground- and surface-water interactions, and the complexity of interactions with Quaternary alluvium and the Little Bighorn River, accurately determining some of the components of recharge and discharge is beyond the scope of this study. Therefore, these components are discussed only qualitatively. No attempt was made to balance recharge and discharge components in a hydrologic budget. However, recharge and discharge estimates could be used as a conceptual model for water flow in the Judith River Formation.

Recharge to the Judith River Formation is by infiltration and subsequent percolation of precipitation, infiltration of streamflow across outcrops, canal leakage, bank storage, and by subsurface inflow from Quaternary high-terrace deposits. Infiltration and subsequent percolation of precipitation typically recharge the Judith River Formation during the fall and winter before the ground freezes, and early spring when evapotranspiration is minimal. On the basis of the average precipitation in the study area from October through April of 6.7 in. (Western Regional Climate Center, 2001) over an area of about 75 mi^2 of outcrop and subcrop (below Quaternary high-terrace deposits), recharge from precipitation cannot be more than about 26,900 acre-ft/yr. Actual recharge from precipitation probably is substantially less than this quantity because some of this precipitation will evaporate, sublimate, transpire, run off, or be retained as soil moisture. Some of this recharge from infiltration and subsequent percolation of precipitation (fig. 3) occurs as subsurface inflow from Quaternary high-terrace deposits where these deposits overlie the Judith River (pl. 1).

Water-level rises in some wells during the fall, winter, and spring (fig. 4; for example, wells W65, W68, W102, W122, and W153) probably result from a combination of precipitation recharge before the ground freezes or after it thaws, infiltration of streamflow across outcrops, and subsurface inflow from Quaternary high-terrace deposits. Above-normal precipitation during some months in 1995 (fig. 3) in the study area (Western Regional Climate Center, 2001) probably caused water levels in some wells, in part, to have an overall increasing trend during the summer of 1995 (fig. 4; wells W65, W68, and W102). However, precipitation from about May through September probably does not substantially recharge the Judith River Formation because evapotranspiration by crops and natural vegetation typically exceeds precipitation in the study area during the growing season in most years (Moulder and others, 1960; Toy and Munson, 1978).

The quantity of recharge to the Judith River Formation by canal leakage also is unknown. However, Moulder and others, (1960) estimated an average leakage rate of 0.00038 ft^3/s in alluvium. Recharge by canal leakage would recharge the Judith River where canals extend along outcrops, generally between Lodge Grass and Crow Agency (fig. 4, for example wells W60, W102, and W110).

The quantity of recharge to the Judith River Formation by infiltration of bank storage during high streamflow is unknown, but probably is limited along the Little Bighorn River because of minimal areas where the river intersects the formation. Figure 4 shows water-level rises in well W153 due, in part, to rising stage of the Little Bighorn River. Moulder and others (1960) determined that well W45 (not shown in fig. 4) also is affected by stage in the Little Bighorn River. The Judith River Formation probably is hydraulically connected to the Little Bighorn River where it crops out or subcrops near the river.

Discharge

Discharge from the Judith River Formation is primarily through upward subsurface outflow to Quaternary alluvium and the Little Bighorn River, withdrawals from wells, and evapotranspiration. Discharge by subsurface outflow to alluvium and the Little Bighorn River is estimated to range from 175 to 1,750 acre-ft/yr (table 1). This estimate was based on Darcy's Law (equation 3) using an areal extent of 24,900 acres (39 mi^2) where the Judith River Formation underlies alluvium, a vertical gradient of 0.07 determined from wells W47 and W48, and a vertical hydraulic conductivity that ranges from 0.1 to 1.0 ft/d. An assumption of the calculation is that vertical gradients are the same throughout the study area and that the vertical hydraulic conductivity is about an order of magnitude less than the horizontal hydraulic conductivity (about 8 and 50 ft^2/d; Moulder and others, 1960). However, vertical gradients and vertical hydraulic conductivities probably vary throughout the study area.

Water in the Judith River Formation is primarily used for either commercial, domestic, or stock-watering purposes. Water from the Judith River Formation is not used for irrigation. Withdrawals from wells for domestic use for the entire study area was estimated to be about 260 acre-ft/yr (see section on "Quaternary alluvium"). The Judith River Formation underlies about 39 mi^2 of alluvium and in these areas both aquifers are used for domestic and stock-watering purposes. The Judith River Formation also is extensively used as a source of domestic and stock-watering supplies where it exists outside of the alluvial valley and in Lodge Grass. Withdrawals from wells for stock-watering purposes is unknown but is assumed to be small because surface water from the river and canals is used extensively for stock watering along the alluvial valley. An estimate of withdrawals from wells from the Judith River Formation is difficult to calculate because of lack of data, but the quantity is most likely less than one-half of the total estimated for domestic use (table 1).

The quantity of discharge from the Judith River Formation by evapotranspiration cannot be estimated from available data. Along the terraces west of the Little Bighorn River and Pass Creek, dryland wheat and native grass grow on Judith River Formation outcrops. Evapotranspiration rates for dryland wheat and native grass range from 1.7 to 1.9 ft per year (Toy and Munson, 1978), which is greater than the average annual precipitation of about 14.9 in. for the study area (Western Regional Climate Center, 2001). The difference between evapotranspiration and average annual precipitation results in a plant-water deficit that requires plants to supplement soil moisture with available ground water in most years. Where the Judith River Formation crops out and the depth to water is less than about 15 ft, water probably is directly discharged by evapotranspiration. In subcrop areas, recharge from Quaternary high-terrace deposits probably is reduced because water is discharged by evapotranspiration from this hydrogeologic unit. Generally, from March through October 1995, above normal precipitation (fig. 3) in the study area (Western Regional Climate Center, 2001) caused water levels in some wells completed in the Judith River Formation (fig. 4, for example wells W65 and W68), to have an overall increasing trend; thus, recharge was greater than discharge during the 1995 growing season.

Water Quality

Based on the laboratory analytical results from samples collected and from data compiled for this study, the major-ion composition of most water in the Judith River Formation was predominated by the sodium cation and the bicarbonate and sulfate anions (pl. 1 and fig. 9). Water from four wells (W65, W85, W102, and W167) was a sodium bicarbonate type, whereas water from two wells (W43 and W160) contained a mixture of magnesium, sodium, and calcium cations and bicarbonate or sulfate anions. Water from wells W43 and W160 was an anomalous water type for the Judith River Formation in the study area because sodium was not the predominant cation. Water from these two wells probably was recharged from either the Reno Canal (well W43) or the Little Bighorn River (well W160). If water from well W160 was recharged primarily from the Little Bighorn River, then the local gradient may trend laterally to the east; thus, the Judith River Formation might not discharge to Quaternary alluvium and the Little Bighorn River in the area near well W160.

Dissolved-solids concentrations in water from the Judith River Formation ranged from 352 to 1,910 mg/L, with a median of 1,000 mg/L. Water from the Judith River Formation generally had a dissolved-solids concentration greater than 1,000 mg/L between Reno Creek and the Little Bighorn Battlefield National Monument (except for wells W64 and W65). The larger dissolved solids in water from this area might reflect the effect of interbedded marine shale in the Judith River Formation. Water from the Judith River Formation generally had a dissolved-solids concentration less than 1,000 mg/L between Wyola and Benteen. The area between Wyola and Benteen coincides with the location of more massive sandstone outcrops of the Judith River Formation along the Little Bighorn River and might indicate the effect of recharge of less mineralized water (median dissolved-solids concentrations of 179 mg/L at site S2 and 350 mg/L at site S25) from the river or irrigation.

The chemical quality of water from the Judith River Formation (table 7) varied and is probably suitable for most domestic uses. Although none of the sampled wells had water with constituent concentrations that exceeded the health-based EPA MCLs, several SDWRs (U.S. Environmental Protection Agency, 2000) were exceeded that may render the water esthetically unsuitable for various uses. The concentration of sulfate in water from 14 wells exceeded the SDWR of 250 mg/L and the concentration of dissolved solids in water from 16 wells exceeded the SDWR of 500 mg/L. The iron SDWR of 0.3 mg/L (300 μg/L) was exceeded in water from 10 wells, whereas concentration of manganese in water from 6 wells exceeded the SDWR of 0.05 mg/L (50 μg/L).

Water from the Judith River Formation might not be suitable for some irrigation applications based on a comparison of specific conductance and the sodium-adsorption ratio (U.S. Salinity Laboratory Staff, 1954). Generally, the water has a high to very high salinity hazard (specific conductance ranges from 880 to 4,470 μS/cm; table 4) and a low to very high sodium hazard (sodium-adsorption ratio ranges from 0.8 to 82, table 7).

SUMMARY

Water from the Quaternary alluvium and the Upper Cretaceous Judith River Formation is the primary source for domestic and stock supplies. Shallow ground water (less than about 100 ft below land surface) generally is not available for domestic and stock use in areas where alluvium or the Judith River Formation do not exist. This report describes the general geology and the water resources of the Quaternary alluvium and the Upper Cretaceous Judith River Formation along the Little Bighorn River within the Crow Indian Reservation of southeastern Montana. Data were collected and compiled for 193 ground-water and 27 surface-water sites.

Quaternary alluvium underlies an area of about 94 mi^2 located primarily along the Little Bighorn River and its major perennial tributaries, Lodge Grass and Pass Creeks. Quaternary alluvium is composed of unconsolidated gravel, sand, silt, and clay that gener-

ally have a combined thickness of less than about 30 ft. Thickness of the probable water-bearing zone within the alluvium ranges from 2 to 39 ft, with a median of 9 ft. The specific capacity of wells completed in Quaternary alluvium ranged from 0.31 to 30 (gal/min)/ft, transmissivity ranged from 230 to 6,900 ft^2/d, and well yields ranged from 4 to 50 gal/min. Low transmissivity, low specific capacity, and low well yield are typical of alluvium deposited by rivers having a small carrying and sorting capacity, which results in deposits containing substantial quantities of fine-grained material. In addition, these deposits might also contain discontinuous or poorly connected lenses of coarser-grained material.

Recharge to Quaternary alluvium is by infiltration and subsequent percolation of precipitation, canal leakage, excess applied irrigation water, bank storage, and by subsurface inflow from alluvium in small ephemeral tributaries adjacent to the Little Bighorn valley and from the underlying Judith River Formation. Discharge from Quaternary alluvium is primarily through evapotranspiration, withdrawals from wells, flow to irrigation drains, and subsurface outflow to the Little Bighorn River. Ground water was estimated to contribute about 15 to 18 percent of the annual daily mean streamflow (in water year 1995) of the Little Bighorn River near Hardin.

Water in Quaternary alluvium generally had high concentrations of dissolved calcium, magnesium, sodium, bicarbonate, sulfate, chloride, and iron. The major-ion composition was predominated by calcium, magnesium, and sodium cations, and bicarbonate and sulfate anions. Dissolved-solids concentrations ranged from 264 to 4,770 mg/L, with a median of 1,450 mg/L. The dissolved-solids concentrations might be high, in part, because Upper Cretaceous rocks underlie and probably affect the water quality in alluvium. The lower dissolved-solids concentrations probably indicate the effect of recharge of less mineralized water from the Little Bighorn River, Lodge Grass Creek, or water from irrigation. The chemical quality of water from alluvium varied and some water can pose a health risk for domestic use.

The Upper Cretaceous Judith River Formation contains an unnamed upper member composed of about 700 ft of sandstone interbedded with sandy shale and shale. The lower member, the Parkman Sandstone Member, is composed of as much as 350 ft of massive sandstone and sandy shale. Specific capacity of wells completed in the Judith River Formation ranged from 0.06 to 7.4 (gal/min)/ft, transmissivity estimates from specific-capacity tests ranged from 39 to 780 ft^2/d, and well yields ranged from 5 to 74 gal/min. Low transmissivity, low specific capacity, and low well yield are typical of the upper part of the Judith River Formation, where interbedded shale and fine-grained sandstone can be lenticularly bedded and laterally discontinuous. The lower part of the Judith River Formation (Parkman Sandstone Member) is a fine-grained sandstone that is massive locally, but also is not uniform throughout the study area.

Recharge to the Judith River Formation is by infiltration and subsequent percolation of precipitation, infiltration of streamflow across outcrops, canal leakage, bank storage, and by subsurface inflow from Quaternary high-terrace deposits. Discharge from the Judith River Formation is primarily through upward subsurface outflow to Quaternary alluvium and the Little Bighorn River, withdrawals from wells, and evapotranspiration.

The major-ion composition of most water in the Judith River Formation was predominated by the sodium cation and the bicarbonate and sulfate anions. Dissolved-solids concentrations in water from the Judith River Formation ranged from 352 to 1,910 mg/L, with a median of 1,000 mg/L. Water from the Judith River Formation generally had a dissolved-solids concentration greater than 1,000 mg/L between Reno Creek and the Little Bighorn Battlefield National Monument. The larger dissolved-solids in water from this area might reflect more interbedded marine shale and sandy shale in the Judith River Formation. Water from the Judith River Formation generally had a dissolved-solids concentration less than 1,000 mg/L between Wyola and Benteen, which might indicate the effect of recharge of less mineralized water from the Little Bighorn River or irrigation. The chemical quality of water from the Judith River Formation varied and is probably suitable for most domestic use.

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DATA

Table 4. Hydrologic and field water-quality data for ground-water sites along the Little Bighorn River and adjacent areas, Montana

[Location and site numbers described in text. Vertical coordinate information is referenced to the National Geodetic Vertical Datum of 1929 (NGVD 29). Water levels measured with a steel tape. Hydrogeologic unit: Qal, Quaternary alluvium (includes low-terrace deposits); Qth, Quaternary high-terrace deposits; Khf, Upper Cretaceous Hell Creek Formation and Fox Hills Sandstone; Kb, Upper Cretaceous Bearpaw Shale; Kjr, Upper Cretaceous Judith River Formation; Ku, Upper Cretaceous rocks, undifferentiated. Primary use of water: C, commercial; H, domestic; S, stock; U, unused. Depth of well: in feet below land surface. Static-water level: in feet below land surface. Method of water level measurement: S, steel tape. Method of discharge measurement: R, reported; V, volumetric. Remarks: QW, quality of water data in table 7; WL, water-level data in table 5. Abbreviations: ft, feet; in., inches; gal/min, gallons per minute; µS/cm, microsiemens per centimeter at 25 °C; °C, degrees Celsius. Symbols: -, --, no data or not applicable]

Location number	Site number	Hydro-geologic unit	Altitude of land surface (ft)	Primary use of water	Depth of well (ft)	Dia-meter of casing (in.)	Static-water level (ft)	Method of water level meas-ure-ment	Date water level meas-ured	Well yield or dis-charge (gal/min)	Method of dis-charge meas-ure-ment	Specific conduc-tance, onsite (µS/cm)	pH, onsite (stand-ard units)	Temper-ature, water, onsite (°C)	Date water-quality parameter measured	Remarks
01S34E17CDCC01	W1	Qal	2,919	U	31	--	--	-	--	--	-	--	--	--	--	--
01S34E19ABCD01	W2	Qal	2,890	U	24	6	3.32	S	06-22-94	20	R	--	--	--	--	--
01S34E19ACAD01	W3	Qal	2,895	H	20	--	--	-	--	--	-	2,770	7.0	13.0	06-22-94	--
01S34E20CDBB01	W4	Qal	2,885	H	18	--	--	-	--	15	R	894	7.4	13.5	06-22-94	--
01S34E28CBBA01	W5	Qal	2,925	H	22	6	13.19	S	06-24-94	--	-	799	7.3	14.0	06-24-94	WL
01S34E28CCCC01	W6	--	2,939	H	--	--	--	-	--	--	-	7,480	7.2	12.0	06-25-94	--
01S34E29ADBB01	W7	Qal	2,928	H	27	6	--	-	--	15	R	910	7.3	13.5	06-26-94	QW
01S34E29BDAD01	W8	Qal	2,920	H	23	6	7.46	S	06-21-94	--	-	1,450	7.5	14.0	06-21-94	--
01S34E33CDCB01	W9	Ku	2,962	H	42	--	3.57	S	06-22-94	--	-	2,800	7.4	15.0	06-22-94	QW
01S34E33DBBA01	W10	Qal	2,945	H	27	6	2.34	S	06-24-94	30	R	2,510	7.3	12.0	06-24-94	QW
01S34E34BCCD01	W11	--	2,940	S	12	--	--	-	--	--	-	3,080	7.3	12.0	06-24-94	--
01S34E34CBDD01	W12	--	2,945	H	20	--	5.96	S	06-23-94	--	-	--	--	--	--	--
02S34E02CBCA01	W13	Qal	2,961	H	23	6	10.66	S	06-28-94	12	R	2,900	7.0	16.5	06-28-94	QW,WL
02S34E02CDDC01	W14	--	2,950	H	--	--	--	-	--	--	-	3,590	7.2	14.0	06-23-94	--
02S34E03AACC01	W15	--	2,950	S	20	--	--	-	--	--	-	2,710	7.4	12.0	06-23-94	--
02S34E03CDCC01	W16	Qal	2,960	H	23	6	11.41	S	06-21-94	--	-	3,160	7.3	11.0	06-21-94	QW
02S34E04AAAA01	W17	Qal	2,945	H	21	6	3.75	S	06-24-94	15	R	3,650	7.2	13.5	06-24-94	QW
02S34E04BBAB01	W18	--	2,970	H	35	--	--	-	--	--	-	2,170	7.6	14.5	06-23-94	--
02S34E06ABAB01	W19	Qth	3,054	H	30	36	10.60	S	06-21-94	--	-	5,580	7.4	11.5	06-21-94	QW
02S34E10AABB01	W20	Qal	2,972	H	--	--	--	--	--	--	-	2,560	7.3	12.0	06-25-94	--
02S34E10BBCA01	W21	Ku	2,980	H	120	6	16.01	S	06-23-94	7	R	5,300	7.2	12.5	06-23-94	WL
02S34E10DBBB01	W22	Qal	2,990	H	29	6	12.90	S	09-21-94	6.5	R	3,750	7.2	14.0	06-25-94	QW, WL
02S34E11AACC01	W23	Qal	2,960	H	19	6	--	-	--	--	-	2,370	7.1	12.0	06-26-94	QW
02S34E11DCCD01	W24	Qal	2,985	H	20	6	3.14	S	06-27-94	6	V	3,150	7.5	12.5	06-27-94	QW
02S34E11DCDA01	W25	Qal	2,985	H	--	--	--	-	--	--	-	2,820	7.3	11.0	09-01-95	QW
02S34E13CBAB01	W26	Qal	2,979	H	22	6	6.29	S	06-27-94	12	V	1,450	7.5	10.5	06-27-94	QW, WL
02S34E13CDDD01	W27	Qal	3,000	H	22	6	6.34	S	06-27-94	4	V	2,220	7.6	13.5	06-27-94	QW
02S34E14ABDC01	W28	Qal	2,990	H	23	6	2.18	S	06-26-94	4	V	3,400	7.2	13.5	06-26-94	QW
02S34E14CADD01	W29	Qal	3,005	H	35	--	--	-	--	8	R	1,970	7.1	14.0	06-24-94	QW

Table 4. Hydrologic and field water-quality data for ground-water sites along the Little Bighorn River and adjacent areas, Montana (Continued)

Location number	Site number	Hydro-geo-logic unit	Altitude of land surface (ft)	Primary use of water	Depth of well (ft)	Diameter of casing (in.)	Static-water level (ft)	Method of water level measure-ment	Date water level measured	Well yield or dis-charge (gal/min)	Method of dis-charge measure-ment	Specific conduc-tance, onsite (µS/cm)	pH, onsite (standard units)	Temper-ature, water, onsite (°C)	Date water-quality parameter measured	Remarks
02S34E16BBCC01	W30	Ku	3,105	H	60	--	--	-	--	--	-	6,630	7.3	13.5	06-22-94	--
02S34E23AAAC01	W31	--	3,010	H	60	--	--	-	--	--	-	1,000	7.4	12.5	06-28-94	--
02S34E23CBAA01	W32	Qal	3,040	H	23	6	--	-	--	4	R	4,910	7.2	14.0	06-24-94	QW
02S34E24ABAB01	W33	Qal	3,000	H	27	6	11.55	S	06-27-94	8	V	2,360	7.6	11.5	06-27-94	QW
02S34E24DBDD01	W34	Qal	3,000	H	10	--	5.82	S	06-26-94	--	-	1,370	7.6	13.0	06-26-94	--
02S34E25BBAB01	W35	Qal	3,019	H	16	--	--	-	--	--	-	2,360	7.4	13.5	06-24-94	--
02S34E35BBAB01	W36	Ku	3,118	H	65	6	16.43	S	06-26-94	--	-	3,270	7.6	12.5	06-26-94	WL
02S34E36ACCC01	W37	Qal	3,021	H	38	6	11.31	S	06-27-94	10	R	2,340	7.4	13.5	06-27-94	QW,WL
02S34E36ACCC02	W38	Qal	3,021	H	38	6	10.14	S	06-27-94	12	R	3,910	7.6	13.5	06-27-94	QW
02S35E30CCBC01	W39	Qal	3,020	H	25	6	9.63	S	06-24-94	--	-	893	7.6	12.5	06-24-94	--
03S34E12DBAB01	W40	Qal	3,040	H	--	--	--	-	--	--	-	823	7.8	11.5	06-24-94	--
03S34E12DCBA01	W41	Qal	3,040	H	--	--	--	-	--	--	-	801	7.7	11.0	06-24-94	--
03S34E13CDAA01	W42	Qal	3,080	H	41	6	23.05	S	06-23-94	--	-	--	--	--	--	QW
03S34E24AAAC01	W43	Kjr	3,065	H	36	6	7.50	S	06-24-94	20	R	--	--	--	--	QW
03S34E18DABD01	W44	Ku	3,220	U	400	6	146.33	S	10-05-94	8.0	V	--	--	13.0	10-27-77	QW,WL
03S35E18DCBD01	W45	Kjr	3,061	U	120	10	8.51	S	06-23-94	74	V	--	--	10.0	06-28-77	QW
03S35E18DCCB01	W46	Qal	3,070	-	10	--	--	-	--	--	-	--	--	10.0	06-29-77	QW
03S35E19AABA01	W47	Qal	3,060	H	36	6	4.93	S	06-21-94	20	R	2,100	7.6	11.0	06-21-94	QW
03S35E19AABA02	W48	Kjr	3,060	U	60	6	5.00	S	06-21-94	10	R	--	--	--	--	--
03S35E19CBDD01	W49	Qal	3,090	H	36	6	5.66	S	06-23-94	30	R	1,530	7.9	10.0	06-23-94	QW,WL
03S35E19DCDA01	W50	--	3,080	H	--	6	5.39	S	06-21-94	--	-	--	--	--	--	--
03S35E24AADB01	W51	Qal	3,065	H	36	6	7.59	S	06-24-94	--	-	--	--	--	--	--
03S35E29ABCC01	W52	Qal	3,090	H	--	6	9.72	S	06-21-94	--	-	3,140	7.4	11.0	06-21-94	QW
03S35E29BDAA01	W53	Qal	3,095	U	25	6	9.94	S	09-20-94	9	R	--	--	--	--	--
03S35E29CDBA01	W54	Kjr	3,100	H	--	6	--	-	--	--	-	1,820	8.7	14.0	06-21-94	QW
03S35E30BADA01	W55	Kjr	3,090	H	80	--	--	-	--	--	-	1,010	7.7	10.0	06-06-94	--
03S35E32DBDA01	W56	Kjr	3,120	H	120	6	--	-	--	12	R	--	--	--	--	QW
03S35E32DDABO1	W57	Kjr	3,120	H	95	6	15.80	S	06-09-94	6.7	V	2,150	8.3	11.0	06-09-94	QW
04S35E04AABC01	W58	Kjr	3,120	H	90	6	10.64	S	06-10-94	--	-	2,800	8.7	10.5	06-10-94	--
04S35E04AACC01	W59	Qal	3,120	U	34	6	3.68	S	06-10-94	17	R	--	--	--	--	QW
04S35E04ABAB01	W60	Kjr	3,105	H	86	6	7.88	S	06-07-94	20	R	2,550	8.6	11.0	06-07-94	QW, WL
04S35E04BBBC01	W61	Qal	3,120	U	23	6	2.18	S	06-25-94	--	-	1,610	7.4	10.0	06-25-94	WL
04S35E04BBBC02	W62	Qal	3,120	H	--	--	1.92	S	06-25-94	--	-	1,610	7.4	10.0	06-25-94	--
04S35E04DDDD01	W63	Kjr	3,135	H	--	--	--	-	--	--	-	1,390	8.7	11.5	06-09-94	--

Table 4. Hydrologic and field water-quality data for ground-water sites along the Little Bighorn River and adjacent areas, Montana (Continued)

Location number	Site number	Hydrogeologic unit	Altitude of land surface (ft)	Primary use of water	Depth of well (ft)	Diameter of casing (in.)	Static-water level (ft)	Method of water level measurement	Date water level measured	Well yield or discharge (gal/min)	Method of discharge measurement	Specific conductance, onsite (µS/cm)	pH, onsite (standard units)	Temperature, water, onsite (°C)	Date water-quality parameter measured	Remarks
04S35E05ACAA01	W64	Kjr	3,180	S	98	6	38.77	S	06-09-94	10	R	--	--	--	--	QW
04S35E05CDCC01	W65	Kjr	3,235	H	80	6	15.03	S	06-26-94	20	R	993	7.9	12.0	06-26-94	QW, WL
04S35E06AAAB01	W66	Kjr	3,150	H	124	6	14.07	S	06-07-94	--	-	1,000	7.5	11.5	06-07-94	--
04S35E06AAAB02	W67	Qal	3,150	U	35	6	21.10	S	06-07-94	30	R	--	--	--	--	WL
04S35E06AAAB03	W68	Kjr	3,150	U	75	6	17.90	S	06-07-94	--	-	--	--	--	--	WL
04S35E06BDCD01	W69	Kjr	3,180	H	66	6	20.03	S	06-07-94	--	-	--	--	--	--	--
04S35E09DABA01	W70	Kjr	3,050	H	50	--	--	-	--	--	-	1,180	7.7	11.0	06-07-94	--
04S35E09DDD 01	W71	Qal	3,145	H	31	6	6.08	S	06-22-94	20	R	--	--	--	--	QW
04S35E11ACCD01	W72	Kb	3,230	H	55	6	14.35	S	06-10-94	--	-	--	--	--	--	--
04S35E11ACCD02	W73	Qal	3,165	H	28	6	6.32	S	06-10-94	--	-	--	--	--	--	--
04S35E12CDCA01	W74	Qal	3,205	H	48	6	16.41	S	06-22-94	17	R	5,080	7.5	11.5	06-22-94	--
04S35E15ABBB01	W75	Kb	3,175	H	80	6	37.64	S	06-25-94	7	R	4,980	7.6	11.0	06-25-94	--
04S35E16DCCC01	W76	Qal	3,160	H	26	6	12.17	S	06-06-94	10	R	2,680	7.4	10.0	06-06-94	QW,WL
04S35E16DDDD01	W77	Qal	3,165	H	43	6	--	-	--	9	R	1150	7.6	10.0	06-07-94	QW
04S35E21AACD01	W78	--	3,175	H	--	--	--	-	--	--	-	--	7.6	11.5	06-09-94	--
04S35E28CBDB01	W79	--	3,190	H	73	--	12.86	S	06-07-94	--	-	3,140	8.5	11.0	06-07-94	WL
04S35E34DAAD01	W80	Kjr	3,235	H	--	--	--	-	--	--	-	3,490	8.3	11.0	06-25-94	--
04S36E18AADC01	W81	--	3,260	H	--	6	27.69	S	06-22-94	--	-	1,810	7.5	10.0	06-22-94	--
04S36E18BABC01	W82	Qal	3,225	H	35	6	5.13	S	06-09-94	--	-	1,850	7.8	10.5	06-09-94	--
04S36E18BCDD01	W83	Kb	3,270	H	130	6	27.54	S	06-09-94	3.5	R	5,990	7.7	12.5	06-09-94	--
04S36E18DBBA01	W84	Kb	3,295	S	66	6	39.50	S	06-09-94	--	-	--	--	--	--	--
05S35E03CC 01	W85	Kjr	3,255	H	505	--	--	-	--	15	-	1,340	8.8	13.0	08-26-53	QW
05S35E03CCBC01	W86	Qal	3,230	H	47	6	--	-	--	10	R	--	8.0	12.0	06-09-94	QW
05S35E09DBDD01	W87	Kjr	3,240	H	135	--	--	-	--	--	-	1,860	8.0	13.0	06-07-94	--
05S35E09DDAA01	W88	Kjr	3,250	H	140	--	--	-	--	--	-	3,140	8.0	12.5	06-09-94	--
05S35E14CBBA01	W89	Kb	3,310	U	59	6	18.60	S	07-15-94	--	-	--	--	--	--	--
05S35E16AADC01	W90	Kjr	3,245	H	65	6	--	S	06-07-94	--	-	1,400	7.7	11.5	06-07-94	QW,WL
05S35E16DDDC01	W91	--	3,280	H	--	--	--	-	--	--	-	643	7.6	11.0	06-07-94	--
05S35E22BDBB01	W92	Kjr	3,265	H	80	6	7.92	S	06-07-94	15	R	1,130	7.5	12.0	06-26-94	--
05S35E22DCBB01	W93	Kjr	3,240	H	130	--	--	-	--	--	-	2,200	9.0	12.0	06-09-94	--
05S35E27BADC01	W94	Kjr	3,285	H	136	4	--	-	--	--	-	1,400	8.6	12.5	07-27-94	QW
05S35E27CCDC01	W95	--	3,320	H	--	--	--	-	--	--	-	1,410	8.5	12.0	06-07-94	--
05S35E34ABBB01	W96	Kjr	3,310	H	130	6	19.84	S	06-27-94	--	-	2,100	8.6	11.0	06-26-94	QW
05S35E34BBBD01	W97	--	3,320	H	--	--	--	-	--	--	-	2,390	7.3	12.0	06-08-94	--
05S35E34DBBB01	W98	Kjr	3,325	H	136	6	16.73	S	06-27-94	30	R	1,850	8.6	12.0	06-27-94	QW

Table 4. Hydrologic and field water-quality data for ground-water sites along the Little Bighorn River and adjacent areas, Montana (Continued)

Location number	Site number	Hydrogeologic unit	Altitude of land surface (ft)	Primary use of water	Depth of well (ft)	Diameter of casing (in.)	Static-water level (ft)	Method of water level measurement	Date water level measured	Well yield or discharge (gal/min)	Method of discharge measurement	Specific conductance, onsite (µS/cm)	pH, onsite (standard units)	Temperature, water, onsite (°C)	Date water-quality parameter measured	Remarks
06S35E01BCAA01	W99	Qal	3,320	H	28	--	--	-	--	--	-	1,390	7.4	12.0	06-26-94	--
06S35E01CABA01	W100	Qal	3,335	H	36	6	3.96	S	06-26-94	--	-	1,580	8.7	11.5	06-26-94	--
06S35E01CBCD01	W101	Kjr	3,370	H	76	--	--	-	--	--	-	1,340	8.6	12.0	06-08-94	--
06S35E11ACBB01	W102	Kjr	3,475	U	65	6	10.93	S	07-12-94	7	R	--	--	--	--	QW, WL
06S35E11ACBB02	W103	Qal	3,475	H	40	--	--	-	--	--	-	1,090	7.5	12.0	07-12-94	--
06S35E11CABC01	W104	Qal	3,495	H	--	--	--	-	--	--	-	745	7.6	9.5	07-13-94	--
06S35E12ACBB01	W105	Kjr	3,350	H	86	6	22.68	S	06-27-94	8	R	880	9.3	12.0	06-27-94	QW
06S35E12BDDC01	W106	Kjr	3,400	H	103	6	50.00	S	06-27-94	--	-	1,250	7.0	12.0	06-27-94	--
06S35E12CBCC01	W107	Kjr	3,470	H	230	6	--	-	--	30	R	--	--	--	--	--
06S35E13ACAC01	W108	Kjr	3,370	-	146	10	--	-	--	--	-	--	--	--	--	--
06S35E13ADCC01	W109	Kjr	3,365	-	143	10	14.04	S	07-12-94	--	-	--	--	--	--	--
06S35E13BABD01	W110	Kjr	3,415	U	300	8	40.10	S	06-27-94	50	R	--	--	--	--	WL
06S35E13CAAA01	W111	Kjr	3,375	C	200	6	12.66	S	07-12-94	25	R	--	--	--	--	--
06S35E13CAAA02	W112	Qal	3,375	H	15	18	11.60	S	07-12-94	--	-	--	--	--	--	--
06S35E13CDAD01	W113	Qal	3,375	U	23	6	2.20	S	07-14-94	--	-	--	--	--	--	--
06S35E13CDCB01	W114	Kjr	3,395	H	27	6	5.15	S	07-13-94	--	-	2,690	7.5	9.5	07-13-94	QW
06S35E13DCBB01	W115	Kjr	3,375	H	60	6	10.29	S	07-14-94	--	-	--	--	--	--	--
06S35E14DCAA01	W116	Qal	3,405	H	26	6	3.60	S	07-12-94	50	R	1,230	7.4	9.5	07-12-94	QW
06S35E22ABCC01	W117	Qal	3,455	H	30	6	13.32	S	07-26-94	10	R	2,220	7.5	8.5	07-26-94	QW
06S35E22BDDD01	W118	Qal	3,460	H	14	6	9.04	S	07-14-94	--	-	--	--	--	--	--
06S35E23BDAD01	W119	--	3,490	H	--	6	9.27	S	07-26-94	--	-	--	--	--	--	--
06S35E23CABB01	W120	Ku	3,510	H	40	--	--	-	--	--	-	2,340	7.7	11.0	07-26-94	--
06S35E23CDCD01	W121	--	3,500	H	--	6	25.23	S	07-26-94	--	-	1,970	7.6	11.0	07-26-94	--
06S35E24CACD01	W122	Kjr	3,420	U	204	6	15.55	S	07-26-94	6	R	--	--	--	--	--
06S35E24CACD02	W123	Kjr	3,420	H	60	6	--	-	--	8	R	2,740	7.4	12.0	07-26-94	QW
06S35E25BAAA01	W124	Kjr	3,410	H	180	6	7.67	S	07-26-94	9	R	4,280	7.3	10.0	07-26-94	--
06S35E25CDBB01	W125	Qal	3,410	U	25	6	8.38	S	07-27-94	--	-	--	--	--	--	WL
06S35E29BABB01	W126	Qal	3,555	H	40	6	6.31	S	07-14-94	4	R	1,050	7.4	11.5	07-14-94	QW,WL
06S35E29CBDC01	W127	Ku	3,555	H	100	--	--	-	--	--	-	2,780	7.2	10.0	07-27-94	--
06S35E31ACCA01	W128	Ku	3,590	H	100	--	36.77	S	07-27-94	--	-	2,490	8.4	11.5	07-27-94	--
06S35E31CBCB01	W129	Ku	3,640	H	100	6	14.37	S	07-27-94	--	-	2,510	7.2	12.5	07-27-94	QW
06S35E35DDAB01	W130	Qal	3,450	H	28	6	6.94	S	07-26-94	--	-	1,470	7.4	10.0	07-26-94	--
06S35E35DDBC01	W131	Qal	3,460	U	25	6	13.00	S	11-17-94	5	R	4,190	7.1	--	07-27-94	QW,WL
06S35E35DDBC02	W132	Qal	3,460	H	27	5	10.97	S	07-27-94	15	R	--	--	--	--	QW

Table 4. Hydrologic and field water-quality data for ground-water sites along the Little Bighorn River and adjacent areas, Montana (Continued)

Location number	Site number	Hydrogeologic unit	Altitude of land surface (ft)	Primary use of water	Depth of well (ft)	Diameter of casing (in.)	Static-water level (ft)	Method of water level measurement	Date water level measured	Well yield or discharge (gal/min)	Method of discharge measurement	Specific conductance, onsite (µS/cm)	pH, onsite (standard units)	Temperature, water, onsite (°C)	Date water-quality parameter measured	Remarks
06S35E36BCBC01	W133	--	3,430	U	--	6	9.30	S	07-26-94	--	-	--	--	--	--	--
06S35E36BCBC02	W134	Qal	3,430	H	25	6	8.93	S	07-26-94	50	R	4,190	7.2	11.5	07-26-94	QW
06S36E06CBBA01	W135	Khf	3,550	U	--	--	--	-	--	--	-	--	--	--	--	--
06S36E18ACAD01	W136	--	3,405	H	--	6	69.96	S	07-12-94	--	-	1,810	9.0	13.5	07-12-94	--
06S36E29CDAC01	W137	Khf	3,450	H	77	6	37.86	S	07-28-94	--	-	1,420	7.8	11.5	07-28-94	--
06S36E29DCDB01	W138	Khf	3,445	H	52	6	30.57	S	07-28-94	--	-	1,390	7.4	13.5	07-28-94	--
06S36E33BACB01	W139	Khf	3,495	H	66	6	42.25	S	07-28-94	--	-	888	--	14.0	07-28-94	--
07S34E11AADB01	W140	Qal	3,725	H	42	6	26.26	S	07-27-94	--	-	658	7.3	13.5	07-27-94	--
07S34E11CBDD01	W141	Ku	3,775	H	81	6	32.32	S	07-27-94	10	R	1,300	7.6	11.0	07-27-94	QW
07S34E12ABBB01	W142	Qal	3,665	H	22	6	5.39	S	07-26-94	20	R	1,550	7.5	10.5	07-26-94	QW
07S34E12ABBB02	W143	Qal	3,665	H	34	6	9.10	S	07-26-94	10	R	1,370	7.4	10.0	07-26-94	QW
07S34E15CBDA01	W144	Qal	3,780	H	27	6	10.17	S	07-13-94	20	R	--	--	--	--	QW, WL
07S34E21CAD01[1]	W145	--	3,845	H	--	--	--	-	--	--	-	771	7.1	11.5	07-28-94	--
07S34E21CCDA01	W146	Qal	3,860	H	--	--	--	-	--	--	-	556	7.5	10.0	07-27-94	--
07S34E29ADCB01	W147	Qal	3,900	H	--	--	--	-	--	--	-	614	7.1	14.0	07-28-94	--
07S35E06BADC01	W148	Qal	3,625	H	30	6	7.29	S	07-28-94	--	-	2,300	6.8	--	07-28-94	--
07S35E06BCA 01	W149	Ku	3,630	H	40	--	9.68	S	07-28-94	--	-	2,000	7.8	9.0	07-28-94	--
07S35E11ACAA01	W150	Kjr	3,490	H	90	6	--	-	--	--	-	4,470	8.6	12.0	07-14-94	--
07S35E11ACAA02	W151	Qal	3,490	U	18	--	8.18	S	07-14-94	--	-	--	--	--	--	QW
07S35E11ACAD01	W152	Qal	3,490	U	11	6	7.02	S	07-14-94	--	-	--	--	--	--	WL
07S35E11ADBA01	W153	Kjr	3,485	U	64	6	9.35	S	07-14-94	--	-	--	--	--	--	WL
07S35E11DBCB01	W154	Qal	3,495	H	25	6	7.56	S	07-28-94	30	R	--	--	--	--	QW
07S35E11DCADO1	W155	--	3,505	H	108	6	10.89	S	07-27-94	--	-	586	7.8	9.0	07-27-94	--
07S35E14ACC01	W156	Qal	3,515	H	20	6	5.34	S	07-28-94	--	-	--	--	--	--	--
07S35E23ABCC01	W157	Kjr	3,560	H	100	6	15.25	S	07-26-94	20	R	1,210	7.7	10.5	07-26-94	QW
07S35E23BDDB01	W158	Qal	3,580	H	35	--	--	-	--	--	-	877	7.4	8.5	07-14-94	--
07S35E26DAB 01	W159	Qal	3,580	H	--	--	12.03	S	07-14-94	--	-	701	7.3	11.5	07-14-94	--
07S35E36CBDB01	W160	Kjr	3,790	U	160	6	102.83	S	07-26-94	10	R	--	--	--	--	QW,WL
08S34E06ACDC01	W161	Qal	4,000	H	30	--	--	-	--	--	-	1,180	7.0	11.0	07-28-94	--
08S35E11BCAC01	W162	Kjr	3,630	H	60	6	8.81	S	07-14-94	7.5	R	1,850	7.4	11.0	07-14-94	--
08S35E14BCCB01	W163	Qal	3,670	H	21	6	5.97	S	09-22-93	50	R	988	8.1	12.0	09-22-93	WL
08S35E14BDBB01	W164	Kjr	3,680	H	58	6	12.91	S	07-14-94	--	-	3,050	7.4	9.5	07-14-94	--
08S35E15ACAA01	W165	Qal	3,680	H	22	6	7.24	S	09-22-93	12	R	1,340	7.4	12.0	09-22-93	--
08S35E15DCDA01	W166	Qal	3,690	-	30	6	--	-		28	-	--	--	--	--	--
08S35E15DDBD01	W167	Kjr	3,685	H	115	6	15.68	S	09-23-93	--	-	1,130	9.3	10.0	09-23-93	QW,WL

Table 4. Hydrologic and field water-quality data for ground-water sites along the Little Bighorn River and adjacent areas, Montana (Continued)

Location number	Site number	Hydrogeologic unit	Altitude of land surface (ft)	Primary use of water	Depth of well (ft)	Diameter of casing (in.)	Static-water level (ft)	Method of water level measurement	Date water level measured	Well yield or discharge (gal/min)	Method of discharge measurement	Specific conductance, onsite (µS/cm)	pH, onsite (standard units)	Temperature, water, onsite (°C)	Date water-quality parameter measured	Remarks
08S35E22CBBB01	W168	Ku	3,725	H	335	4	--	-	--	--	-	2,080	8.7	11.5	09-22-93	--
08S35E22CBBC01	W169	Qal	3,730	H	17	--	8.81	S	09-21-93	--	-	693	7.5	9.5	09-21-93	--
08S35E23CBAA01	W170	Kjr	3,745	H	60	--	--	-	--	--	-	3,060	8.5	11.5	07-14-94	--
08S35E23CBCB01	W171	Kjr	3,750	H	250	6	10.50	S	07-13-94	5	R	2,130	8.8	11.0	07-13-94	--
08S35E26CDBB01	W172	Kjr	3,770	H	134	6	26.64	S	07-13-94	5	R	4,430	7.2	10.5	07-13-94	--
08S35E27AABC01	W173	Qal	3,740	S	24	6	6.62	S	07-13-94	--	-	869	7.3	11.0	07-13-94	--
08S35E28ABAC01	W174	Qal	3,755	H	27	6	11.76	S	09-22-93	--	-	489	7.7	9.0	09-22-93	QW,WL
08S35E28BDDD01	W175	Qal	3,760	H	25	--	--	-	--	--	-	1,050	7.1	11.0	09-21-93	--
08S35E29DCAD01	W176	Qal	3,800	H	19	6	6.13	S	09-23-93	--	-	--	--	--	--	--
08S35E32ABD 01	W177	Qal	3,810	H	6	36	5.23	S	09-21-93	--	-	1,330	7.4	22.0	09-21-93	--
08S35E32ADDA01	W178	Qal	3,790	H	20	48	9.66	S	09-23-93	6.7	V	1,160	6.9	11.0	09-23-93	--
08S35E32CADA01	W179	Qal	3,821	H	8	36	5.39	S	09-21-93	5.2	V	576	7.4	11.5	09-22-93	--
08S35E32CDCB01	W180	Qal	3,835	H	10	36	6.09	S	09-22-93	--	-	455	7.6	12.0	09-22-93	--
08S35E35ABCC01	W181	Kjr	3,790	H	200	6	14.13	S	07-13-94	12	R	2,190	7.3	9.5	07-13-94	--
09S34E01CDBB01	W182	Qal	3,930	H	16	6	--	-	--	30	R	1,430	7.3	12.0	09-21-93	QW
09S34E12ABBA01	W183	Qal	3,920	H	22	6	16.95	S	09-22-93	--	-	841	7.4	11.0	09-22-93	--
09S34E12BCBB01	W184	Qal	3,945	H	30	6	15.42	S	09-20-93	--	-	431	7.4	12.5	09-20-93	WL
09S35E01CBAB01	W185	Kjr	3,930	H	100	6	27.67	S	07-13-94	10	R	2,240	7.3	10.0	07-13-94	--
09S35E04BBBA01	W186	Ku	3,870	H	360	6	41.60	S	07-12-94	--	-	1,510	8.9	14.5	07-12-94	QW,WL
09S35E04BBBB01	W187	Ku	3,865	H	60	6	38.09	S	09-21-93	--	-	3,360	7.0	11.0	09-21-93	--
09S35E06CBDD01	W188	Qal	3,895	H	22	6	9.53	S	09-20-93	20	R	796	7.3	10.0	09-20-93	--
09S35E12ACAA01	W189	Qal	3,910	H	--	--	5.90	S	07-12-94	--	-	1,020	7.3	9.0	07-12-94	--
09S35E12BABA01	W190	Qal	3,870	H	25	6	18.10	S	07-12-94	5	R	1,670	7.5	--	07-12-94	QW
09S35E21DBCA01	W191	Qal	4,005	H	43	6	15.33	S	07-12-94	--	-	683	7.6	14.0	07-12-94	--
09S35E27BDAA01	W192	Qal	4,170	H	23	6	12.25	S	07-12-94	15	R	821	7.4	9.0	07-12-94	--
09S35E31CAAB01	W193	Qal	4,375	H	9	8	4.56	S	07-12-94	--	-	712	7.3	8.5	07-12-94	--

[1]Ground-water site W145 is the only spring that was inventoried.

Table 5. Water-level data from selected wells along the Little Bighorn River and adjacent areas, Montana
[Site number described in text. Abbreviations: ft, feet below land surface]

Date of water-level measurement	Static-water level, in ft	Date of water-level measurement	Static-water level, in ft	Date of water-level measurement	Static-water level, in ft	Date of water-level measurement	Static-water level, in ft
W5		W13		W21		W22	
09-21-94	17.80	06-28-94	10.66	06-23-94	16.01	09-21-94	12.90
10-17-94	15.93	10-17-94	10.55	09-20-94	16.01	10-17-94	12.60
11-18-94	14.36	11-18-94	10.61	10-17-94	16.16	11-18-94	12.46
12-13-94	17.97	12-13-94	10.02	11-18-94	16.18	12-13-94	12.36
01-10-95	16.81	01-10-95	9.86	12-13-94	16.40	01-10-95	12.47
02-07-95	17.37	02-07-95	9.54	01-10-95	16.70	02-07-95	12.27
03-14-95	17.39	03-14-95	9.42	02-07-95	15.84	03-15-95	11.86
04-12-95	17.28	04-12-95	8.59	03-15-95	15.57	04-12-95	10.22
05-09-95	17.41	04-28-95	8.64	04-12-95	14.61	05-09-95	10.81
06-07-95	15.98	05-09-95	8.71	04-28-95	14.49	05-24-95	10.00
06-21-95	15.65	05-24-95	9.55	05-09-95	13.91	06-07-95	10.76
07-18-95	13.54	06-07-95	8.80	05-24-95	13.30	06-21-95	11.12
08-10-95	15.71	06-21-95	9.12	06-07-95	12.99	07-06-95	11.28
08-22-95	12.82	07-18-95	9.63	06-21-95	13.48	07-18-95	11.48
		08-10-95	11.01	07-06-95	14.29	08-10-95	11.95
		08-22-95	10.69	07-18-95	15.02	08-22-95	11.87
		09-19-95	11.00	08-10-95	16.11	09-19-95	12.02
		10-10-95	10.80	08-22-95	16.05	10-10-95	11.89
		10-30-95	10.65	09-19-95	15.87	10-30-95	12.09
				10-10-95	15.65		
				10-30-95	15.98		

Date of water-level measurement	Static-water level, in ft	Date of water-level measurement	Static-water level, in ft	Date of water-level measurement	Static-water level, in ft	Date of water-level measurement	Static-water level, in ft
W26		W36		W37		W44	
06-27-94	6.29	06-26-94	16.43	06-27-94	11.31	10-26-77	126.20
09-21-94	6.66	09-21-94	16.07	09-21-94	11.56	04-12-78	128.50
10-17-94	6.05	10-17-94	15.88	10-17-94	11.56	06-05-78	85.76
11-18-94	5.99	11-18-94	16.01	11-18-94	11.74	08-21-78	97.86
12-13-94	6.08	12-13-94	17.75	12-13-94	13.56	10-25-78	100.36
01-10-95	6.13	01-10-95	20.30	01-10-95	13.73	01-08-79	111.94
02-07-95	5.33	02-07-95	21.76	02-07-95	13.66	03-12-79	119.47
03-14-95	5.55	03-15-95	18.58	03-15-95	13.30	06-04-79	80.56
04-12-95	5.47	04-12-95	19.37	04-12-95	13.40	09-13-79	72.53
04-28-95	4.48	04-28-95	15.94	04-28-95	13.26	10-24-83	147.40
05-09-95	5.06	05-09-95	16.15	05-09-95	13.20	12-06-84	158.60
05-24-95	3.31	05-24-95	16.58	05-24-95	13.21	11-14-85	163.59
06-07-95	4.83	06-07-95	18.99	06-07-95	12.75	10-15-86	101.54
06-21-95	4.30	06-21-95	18.18	06-21-95	11.87	10-06-87	106.69
07-06-95	2.81	07-06-95	15.68	07-06-95	11.39	10-03-88	114.92
07-18-95	5.63	07-18-95	16.61	07-18-95	11.45	09-19-89	109.69
08-10-95	6.31	08-10-95	16.87	08-11-95	10.50	09-27-90	128.82
08-22-95	6.39	08-23-95	16.32	08-22-95	9.93	09-11-91	137.75
09-19-95	6.43	09-19-95	17.52	09-19-95	11.51	08-20-92	140.22
10-10-95	6.15	10-11-95	16.70	10-11-95	12.30	08-11-93	134.35
10-30-95	6.08	10-30-95	16.90			10-05-94	146.33
						10-05-95	125.60

Table 5. Water-level data from selected wells along the Little Bighorn River and adjacent areas, Montana (Continued)

Date of water-level measurement	Static-water level, in ft	Date of water-level measurement	Static-water level, in ft	Date of water-level measurement	Static-water level, in ft	Date of water-level measurement	Static-water level, in ft
W49		W60		W61		W65	
06-23-94	5.66	06-07-94	7.88	06-25-94	2.18	06-26-94	15.03
09-19-94	6.63	09-19-94	9.57	12-13-94	5.94	09-19-94	15.69
10-17-94	6.20	10-17-94	8.46	01-10-95	6.54	10-17-94	15.21
11-17-94	6.42	11-17-94	8.37	02-07-95	5.94	11-17-94	15.16
12-13-94	6.53	12-13-94	9.25	03-14-95	5.57	12-12-94	15.22
01-10-95	6.69	01-10-95	8.21	04-12-95	5.16	01-09-95	15.27
02-07-95	6.20	02-07-95	9.44	04-28-95	5.94	02-07-95	15.23
03-14-95	5.74	03-14-95	9.07	05-09-95	5.87	03-14-95	14.98
04-12-95	5.79	04-12-95	9.25	05-24-95	5.00	04-12-95	14.75
04-28-95	6.54	04-28-95	8.97	06-07-95	5.72	04-28-95	14.71
05-09-95	5.65	05-09-95	8.93	06-20-95	3.80	05-09-95	14.59
05-24-95	5.21	05-24-95	8.35	07-06-95	2.44	05-24-95	14.30
06-07-95	5.54	06-07-95	8.78	07-18-95	3.43	06-07-95	14.13
06-20-95	6.28	06-21-95	7.96	08-10-95	2.73	06-21-95	14.15
07-06-95	5.70	07-06-95	6.64	08-22-95	3.24	07-06-95	12.95
07-18-95	6.17	07-18-95	7.54	09-18-95	4.05	07-18-95	13.98
08-11-95	4.97	08-10-95	7.91	10-11-95	4.78	08-11-95	14.42
08-22-95	5.78	08-22-95	7.44	10-30-95	5.40	08-22-95	13.93
09-19-95	6.52	09-19-95	8.28			09-19-95	14.05
10-11-95	6.65	10-11-95	9.32			10-11-95	14.03
10-30-95	6.64	10-30-95	8.84			10-30-95	14.00

Date of water-level measurement	Static-water level, in ft	Date of water-level measurement	Static-water level, in ft	Date of water-level measurement	Static-water level, in ft	Date of water-level measurement	Static-water level, in ft
W67		W68		W76		W79	
06-07-94	21.10	06-07-94	17.90	06-06-94	12.17	06-07-94	12.86
09-19-94	20.75	09-19-94	17.74	06-26-94	12.32	09-19-94	14.40
10-17-94	20.08	10-17-94	17.35	09-19-94	14.55	10-18-94	14.01
11-17-94	20.03	11-17-94	17.33	10-17-94	14.08	11-17-94	14.06
12-12-94	20.78	12-12-94	17.58	11-17-94	13.37	12-12-94	14.16
01-09-95	20.05	01-09-95	17.61	12-12-94	13.29	01-09-95	13.90
02-07-95	20.11	02-07-95	17.66	01-09-95	13.10	02-06-95	13.30
03-14-95	20.62	03-14-95	17.62	02-06-95	12.40	03-14-95	13.77
04-12-95	19.76	04-12-95	17.49	03-14-95	12.22	04-12-95	13.67
05-09-95	19.78	05-09-95	17.47	04-12-95	12.16	05-09-95	13.19
06-07-95	19.67	06-07-95	16.88	05-09-95	12.08	06-07-95	12.30
06-20-95	19.64	06-20-95	16.92	06-07-95	11.23	06-20-95	11.62
07-18-95	19.46	07-18-95	16.80			07-17-95	11.74
08-11-95	19.49	08-11-95	17.03			08-11-85	13.40
08-22-95	19.48	08-22-95	16.79			08-22-95	13.45
09-19-95	19.45	09-19-95	16.73			09-09-95	13.82
10-11-95	19.37	10-11-95	16.58			10-11-95	13.95
10-30-95	19.27	10-30-95	16.58			10-30-95	13.80

Table 5. Water-level data from selected wells along the Little Bighorn River and adjacent areas, Montana (Continued)

Date of water-level measurement	Static-water level, in ft	Date of water-level measurement	Static-water level, in ft	Date of water-level measurement	Static-water level, in ft	Date of water-level measurement	Static-water level, in ft
W90		W102		W110		W122	
03-15-95	6.47	07-12-94	10.93	06-27-94	40.10	07-26-94	15.55
04-12-95	6.35	09-19-94	11.01	09-19-94	34.26	09-19-94	16.28
04-28-95	6.23	10-18-94	10.53	10-18-94	35.97	10-18-94	16.16
05-09-95	6.51	11-17-94	10.25	11-17-94	37.26	11-17-94	16.95
05-24-95	6.32	12-12-94	10.09	12-12-94	38.80	12-12-94	16.00
06-07-95	6.74	01-09-95	10.08	01-09-95	40.23	01-09-95	16.47
06-20-95	7.59	02-06-95	9.61	02-06-95	41.40	02-06-95	15.92
07-06-95	9.18	03-14-95	9.62	03-14-95	42.34	03-14-95	14.78
07-17-95	8.14	04-12-95	9.54	04-12-95	41.42	04-12-95	15.10
08-11-95	8.00	04-28-95	9.47	04-28-95	42.30	05-09-95	14.86
08-23-95	7.90	05-09-95	9.41	05-09-95	42.53	06-07-95	15.15
09-19-95	8.00	05-24-95	9.05	05-24-95	41.93	06-20-95	14.19
10-12-95	7.67	06-07-95	9.35	06-07-95	39.64	07-17-95	14.98
10-30-95	7.42	06-20-95	9.56	06-20-95	41.97	08-11-95	15.95
		07-06-95	9.88	07-06-95	42.00	08-23-95	15.50
		07-17-95	9.93	07-17-95	42.48	09-18-95	15.85
		08-11-95	9.75	08-11-95	40.30	10-11-95	15.66
		08-23-95	10.29	08-23-95	35.62	10-30-95	15.62
		09-18-95	9.99	09-19-95	31.15		
		10-11-95	9.74	10-11-95	31.45		
		10-30-95	9.62	10-30-95	33.68		

Date of water-level measurement	Static-water level, in ft	Date of water-level measurement	Static-water level, in ft	Date of water-level measurement	Static-water level, in ft	Date of water-level measurement	Static-water level, in ft
W125		W126		W131		W144	
07-27-94	8.38	07-14-94	6.31	11-17-94	13.00	07-13-94	10.17
10-19-94	8.17	09-20-94	13.57	12-12-94	12.77	09-19-94	10.82
11-17-94	8.22	10-18-94	16.16	01-09-95	12.80	10-18-94	10.63
12-12-94	8.13	11-17-94	15.71	02-06-95	11.96	11-17-94	10.82
01-09-95	7.87	12-12-94	15.34	03-14-95	11.88	12-12-94	10.59
02-06-95	7.66	01-09-95	13.70	04-12-95	11.53	01-09-95	10.72
03-14-95	7.69	02-06-95	13.37	04-28-95	11.32	02-06-95	10.56
04-12-95	7.73	03-14-95	14.57	05-09-95	11.74	03-14-95	10.55
04-28-95	7.75	04-12-95	14.31	05-24-95	8.90	04-12-95	10.60
05-09-95	6.79	04-28-95	14.74	06-07-95	9.19	05-09-95	9.82
05-24-95	6.04	05-09-95	13.29	06-20-95	8.09	06-07-95	9.15
06-07-95	5.87	05-24-95	11.40	07-06-95	9.10	06-20-95	9.16
06-20-95	5.65	06-07-95	11.93	07-17-95	9.59	07-17-95	9.95
07-06-95	6.98	07-06-95	12.61	08-11-95	10.55	08-11-95	10.32
07-17-95	7.46	07-17-95	11.99	08-23-95	10.98	08-23-95	10.39
08-11-95	8.32	08-11-95	7.75	09-18-95	11.78	09-18-95	10.45
08-23-95	8.48	08-23-95	8.51	10-11-95	11.64	10-11-95	10.55
		09-18-95	4.93	10-30-95	11.77	10-30-95	10.49
		10-11-95	8.23				
		10-30-95	12.32				

Table 5. Water-level data from selected wells along the Little Bighorn River and adjacent areas, Montana (Continued)

Date of water-level measurement	Static-water level, in ft	Date of water-level measurement	Static-water level, in ft	Date of water-level measurement	Static-water level, in ft	Date of water-level measurement	Static-water level, in ft
W152		W153		W160		W163	
07-14-94	7.02	07-14-94	9.35	07-26-94	102.83	07-27-94	5.97
09-21-94	8.79	09-21-94	10.52	09-20-94	102.80	09-20-94	6.16
10-18-94	8.33	10-18-94	9.59	10-19-94	103.05	10-19-94	5.45
11-17-94	7.97	11-17-94	9.67	11-17-94	103.35	11-17-94	5.47
12-12-94	7.87	12-12-94	9.62	12-12-94	102.76	12-12-94	5.42
01-09-95	7.70	01-09-95	8.97	01-09-95	102.43	01-09-95	4.83
02-06-95	7.19	02-06-95	9.18	02-06-95	102.82	02-06-95	5.06
03-14-95	6.92	03-14-95	8.93	03-14-95	102.80	03-14-95	4.99
04-12-95	6.48	04-12-95	9.08	04-12-95	102.72	04-12-95	5.14
05-09-95	5.96	05-09-95	8.57	05-09-95	102.72	04-28-95	4.98
06-07-95	3.95	06-07-95	6.04	06-07-95	102.67	05-09-95	5.14
06-20-95	4.60	06-20-95	6.12	06-20-95	102.65	05-24-95	2.55
07-17-95	5.80	07-17-95	8.21	07-17-95	102.68	07-06-95	3.31
08-11-95	6.61	08-11-95	9.15	08-23-95	102.70	07-17-95	4.33
08-23-95	7.10	08-23-95	9.40	09-18-95	102.66	08-11-95	5.69
09-18-95	7.42	09-18-95	9.49			08-22-95	5.86
10-11-95	7.22	10-11-95	9.35			09-18-95	5.80
10-30-95	7.03	10-30-95	9.24			10-11-95	5.67
						10-30-95	5.55

Date of water-level measurement	Static-water level, in ft	Date of water-level measurement	Static-water level, in ft	Date of water-level measurement	Static-water level, in ft	Date of water-level measurement	Static-water level, in ft
W167		W174		W184		W186	
09-23-93	15.68	09-22-93	11.76	09-20-93	17.40	07-12-94	41.60
07-15-94	14.85	07-15-94	11.44	07-15-94	15.42	10-18-94	44.35
09-20-94	15.20	09-20-94	11.88	09-20-94	15.87	11-17-94	47.40
10-18-94	14.88	10-19-94	11.51	10-18-94	15.83	12-12-94	48.15
11-17-94	15.12	11-17-94	11.87	11-17-94	16.04	01-09-95	48.94
12-12-94	15.38	12-12-94	11.59	12-12-94	16.09	02-06-95	56.72
01-09-95	15.29	01-09-95	11.23	01-09-95	15.71	03-14-95	49.61
02-06-95	18.49	02-06-95	11.92	02-06-95	16.11	04-12-95	49.91
03-14-95	15.10	03-14-95	12.02	03-14-95	16.18	05-09-95	51.29
04-12-95	15.68	04-12-95	11.85	04-12-95	15.97	06-07-95	49.03
05-09-95	15.09	05-09-95	11.33	05-09-95	12.86	06-20-95	48.12
06-07-95	13.87	06-07-95	8.73	06-07-95	12.40	07-17-95	45.45
06-20-95	14.60	06-20-95	8.81	06-20-95	13.11	08-11-95	42.03
07-17-95	14.36	07-17-95	10.34	07-17-95	14.60	08-23-95	44.65
08-11-95	16.56	08-11-95	11.34	08-11-95	15.25	09-19-95	45.53
08-23-95	16.73	08-22-95	11.52	08-23-95	15.38	10-11-95	45.16
09-18-95	15.40	09-18-95	11.45	09-18-95	15.52		
10-11-95	14.95	10-11-95	11.50	10-11-95	15.60		
		10-30-95	10.21	10-30-95	15.73		

Table 6. Hydrogeologic data and estimates of transmissivity at selected wells completed in the Quaternary alluvium and the Upper Cretaceous Judith River Formation along the Little Bighorn River and adjacent areas, Montana

[Location and site numbers described in text. Source of discharge and water-level data: D, drillers' log; S, U.S. Geological Survey. Abbreviations: ft, feet below land surface; ft^2/d, feet squared per day; gal/min, gallons per minute; (gal/min)/ft, gallons per minute per foot of drawdown; in., inch. Remarks: first letters indicate whether static water-level measurement was under confined conditions—C, or unconfined conditions—UC; second letters indicate whether drawdown resulted in confined conditions—C, or unconfined conditions—UC. Symbol: --, no data or not determined]

Location number	Site number	Top of water-bearing zone (ft)	Top of perforation (ft)	Bottom of perforation (ft)	Diameter of perforated interval (in.)	Well yield or discharge (gal/min)	Source of discharge data	Static-water level (ft)	Source of water-level data	Pumping time (hours)	Drawdown (ft)	Specific capacity [(gal/min)/ft]	Estimated transmissivity (ft^2/d)	Remarks
Quaternary alluvium														
01S34E19ABCD01	W2	6	13	15	4	20	D	5	D	2	3	6.7	--	C,UC
01S34E20CDBB01	W4	--	--	--	--	15	D	12.0	D	1	1.2	13	--	--
01S34E29ADBB01	W7	18	22	27	6	15	D	17	D	2	3	5.0	--	C,UC
01S34E33DBBA01	W10	19	24	27	6	30	D	7	D	2	5	6.0	1,400	C,C
02S34E02CBCA01	W13	18	18	23	6	12	D	10	D	2	5	2.4	550	C,C
02S34E04AAAA01	W17	--	--	--	--	15	D	5	D	1	6	2.5	--	--
02S34E10DBBB01	W22	20	24	29	6	6.5	D	14	D	2	9	.72	--	C,UC
02S34E11DCCD01	W24	--	--	--	--	6	S	3.14	S	.25	1.24	4.8	--	--
		--	15	20	6	10	D	4	D	2	.5	20	--	--
02S34E13CBAB01	W26	17	--	--	--	12	S	6.29	S	.28	4.36	2.8	470	C,C
		17	17	22	6	7	D	9	D	2	7	1.0	230	C,C
02S34E13CDDD01	W27	17	--	--	--	4	S	6.34	S	.16	1.52	2.6	520	C,C
		17	17	22	6	15	D	9	D	2	6	2.5	580	C,C
02S34E14ABDC01	W28	15	19	23	6	4	S	2.18	S	.16	13.1	.31	--	C,UC
		15	--	--	--	4	D	6	D	2	10	.40	--	C,UC
02S34E23CBAA01	W32	18	20	23	6	4	D	18	D	3	5	.80	--	UC,UC
02S34E24ABAB01	W33	19	--	--	--	8	S	11.55	S	.16	1.65	4.8	--	C,C
		19	22	27	6	20	D	12	D	2	7	2.9	670	C,C
02S34E36ACCC01	W37	24	33	38	6	10	D	12	D	2	19	.52	--	C,UC
02S34E36ACCC02	W38	23	33	38	6	12	D	13	D	2	18	.66	--	C,UC
03S35E19AABA01	W47	20	31	36	--	20	D	5	D	2	24	.83	--	C,UC
03S35E19CBDD01	W49	26	33	36	6	30	D	5	D	2	8	3.8	880	C,C
03S35E29BDAA01	W53	15	20	25	6	9	D	11	D	4	1.80	5.0	1,200	C,C
04S35E04AACC01	W59	18	25	30	6	17	D	8	D	4	10	1.7	--	C,UC
04S35E09DDD 01	W71	18	26	31	6	20	D	7	D	2	5	4.0	920	C,C
04S35E12CDCA01	W74	30	43	48	6	17	D	28	D	3	12	1.4	--	C,UC
04S35E16DCCC01	W76	20	22	26	6	10	D	15	D	2	3	3.3	810	C,C
05S35E03CCBC01	W86	29	32	34	6	10	D	24	D	3	2	5.0	1,200	C,C
06S35E14DCAA01	W116	18	22	26	6	50	D	5	D	2	3	17	3,900	C,C
06S35E22ABCC01	W117	16	26	30	6	10	D	17	D	4	5	2.0	--	UC,UC
06S35E29BABB01	W126	19	19	24	6	4	D	19	D	2	3	1.3	--	UC,UC
06S35E35DDBC01	W131	18	20	25	6	5	D	15	D	2	5	1.0	--	C,UC
06S35E35DDBC02	W132	17	19	24	6	15	D	14	D	2	1	15	3,500	C,C
06S35E36BCBC02	W134	18	20	25	6	50	D	9	D	2	6	8.3	1,900	C,C
07S34E12ABBB01	W142	17	17	22	6	20	D	10	D	2	7	2.9	--	C,UC
07S34E12ABBB02	W143	20	26	31	6	10	D	13.8	D	4	4.5	2.2	550	C,C
07S34E15CBDA01	W144	18	22	27	6	20	D	7	D	2	10	2.0	460	C,C
07S35E11DBCB01	W154	15	20	25	6	30	D	7	D	2	1	30	6,930	C,C
08S35E14BCCB01	W163	10	18	21	6	50	D	6	D	2	9	5.6	--	C,UC

Table 6. Hydrogeologic data and estimates of transmissivity for selected wells completed in the Quaternary alluvium and the Upper Cretaceous Judith River Formation along the Little Bighorn River and adjacent areas, Montana (Continued)

Location number	Site number	Top of water-bearing zone (ft)	Top of perforation (ft)	Bottom of perforation (ft)	Diameter of perforated interval (in.)	Well yield or discharge (gal/min)	Source of discharged data	Static-water level (ft)	Source of water-level data	Pumping time (hours)	Drawdown (ft)	Specific capacity [(gal/min)/ft[	Estimated transmissivity (ft^2/d)	Remarks
Quaternary alluvium--Continued														
08S35E15ACAA01	W165	17	17	22	6	12	D	8	D	2	7	1.7	390	C,C
08S35E15DCDA01	W166	6	14	19	6	28	D	6	D	8	10	2.8	--	UC,UC
09S34E01CDBB01	W182	8	10	16	6	30	B	9	D	1	1	30	--	UC,UC
09S35E06CBDD01	W188	10	17	22	6	20	D	8	D	2	3	6.6	--	C,UC
09S35E12BABA01	W190	18	20	25	6	5	D	19	D	2	2	2.5	--	UC,UC
09S35E27BDAA01	W191	17	18	23	6	15	D	15	D	3	2	7.5	--	C,UC
Upper Cretaceous Judith River Formation														
03S34E24AAAC01	W43	28	31	36	6	20	D	8	D	2	8	2.5	560	C,C
03S35E18DCBD01	W45	59	20	120	10	74	S	10.05	S	24	9.95	7.4	[1]780	C,C
03S35E19AABA02	W48	28	40	60	6	10	D	7	D	2	5	2.0	450	C,C
03S35E32DBDA01	W56	82	115	120	6	12	D	18.8	D	4	33.8	.40	100	C,C
03S35E32DDAB01	W57	50	--	--	--	6.7	S	15.80	S	.5	4.28	1.6	280	C,C
		50	75	95	4	10	D	20	D	3	5	2.0	490	C,C
04S35E04ABAB01	W60	41	81	86	4	20	D	16	D	2	25	.80	--	C,UC
04S35E05ACAA01	W64	73	71	83	6	10	D	42	D	2	38	.26	--	C,UC
04S35E05CDCC01	W65	48	65	70	4	20	D	14	D	2	9	2.2	510	C,C
04S35E06AAAB03	W68	60	35	75	4.5	15	D	18	D	1	12	1.2	310	C,C
05S35E22BDBB01	W92	48	48	75	4	15	D	12	D	3	12	1.2	300	C,C
05S35E34DBBB01	W98	--	123	136	4	30	D	13.5	D	4	62	.48	120	--
06S35E11ACBB01	W102	60	60	65	4	7	D	15	D	2	42	.16	39	C,C
06S35E12ACBB01	W105	68	81	86	4	8	D	30	D	2	48	.16	--	C,UC
06S35E12CBCC01	W107	--	40	230	6	30	D	8	D	3	152	.20	--	UC,UC
06S35E13BABD01	W110	35	35	75	6	50	D	30	D	1	230	.22	--	C,UC
		35	220	260	6	--	--	--	--	--	--	--	--	--
06S35E13CAAA01	W111	45	50	55	4	25	D	11	D	2	135	.20	--	C,UC
		45	100	105	4	--	--	--	--	--	--	--	--	--
		45	180	185	4	--	--	--	--	--	--	--	--	--
06S35E24CACD01	W122	12	62	68	6	6	D	18.5	D	2	71.5	.08	--	UC,UC
06S35E24CACD02	W123	38	45	50	4	8	D	24	D	3	19	.42	--	C,UC
06S35E25BAAA01	W124	144	140	180	4	9	D	6	D	--	109	.08	--	C,C
07S35E23ABCC01	W157	57	86	96	4	20	D	16	D	2	42	.48	--	C,UC
07S35E36CBDB01	W160	117	140	160	4	10	D	108	D	3	4	2.5	620	C,C
08S35E11BCAC01	W162	53	53	58	4	7.5	D	25	D	2	25	.30	70	C,C
08S35E26CDBB01	W171	114	125	130	4	5	D	47	D	2	75	.06	--	C,UC
08S35E35ABCC01	W181	132	6	--	--	12	D	12	D	1	108	.11	--	C,C
09S35E01CBAB01	W185	75	85	90	4	10	D	26	D	2.5	54	.17	--	C,UC

[1]From Moulder and others, (1960, fig. 12).

Table 7. Physical properties and major-ion, trace-element, and radon concentrations in water from selected wells along the Little Bighorn River and adjacent areas, Montana

[Location and site numbers described in text. Hydrogeologic unit: Qal, Quaternary alluvium (includes low-terrace deposits); Qth, Quaternary high-terrace deposits; Kjr, Upper Cretaceous Judith River Formation, Ku, Upper Cretaceous rocks, undifferentiated. Abbreviations: e, estimated; µS/cm, microsiemens per centimeter at 25 degrees Celsius; °C, degrees Celsius; mg/L, milligrams per liter; µg/L, micrograms per liter; pCi/L, picocuries per liter. Remarks: First entry is collecting agency: IHS, Indian Health Service; S, U.S. Geological Survey. Second entry is analyzing agency: CL, Commercial Laboratory; MBMG, Montana Bureau of Mines and Geology; S, U.S. Geological Survey. Third entry is quality-assurance sample: QA-B, quality-assurance sample, field blank; QA-R, quality-assurance sample, replicate. Symbols: --, no data; <, less than minimum reporting level]

Location number	Site number	Hydrogeologic unit	Date	Specific conductance, onsite (µS/cm)	pH, onsite (standard units)	Temperature, water, onsite (°C)	Hardness, total (mg/L as $CaCO_3$)	Calcium, dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)	Sodium, dissolved (mg/L as Na)	Sodium adsorption ratio	Potassium, dissolved (mg/L as K)	Bicarbonate, onsite[1] (mg/L as HCO_3)	Carbonate, onsite[1] (mg/L as CO_3)
01S34E29ADBB01	W7	Qal	11-08-85	--	7.4	--	450	96	50	49	1	5.0	437	0
01S34E33CDCB01	W9	Ku	12-12-78	--	7.0	--	2,400	480	290	650	6	10	476	0
01S34E33DBBA01	W10	Qal	08-28-95	--	7.4	--	930	190	110	180	3	6.0	462	0
02S34E02CBCA01	W13	Qal	01-09-86	--	7.3	--	560	110	69	98	2	4.0	473	0
02S34E03CDCC01	W16	Qal	08-25-87	--	7.2	--	1,600	360	160	170	2	7.0	377	0
02S34E04AAAA01	W17	Qal	12-12-78	--	7.1	--	1,500	280	190	340	4	7.0	415	0
	W17		08-30-95	3,610	7.3	10.5	1,600	330	180	290	3	7.4	440	0
02S34E06ABAB01	W19	Qth	08-30-95	7,490	7.3	13.0	3,100	340	550	900	7	29	476	0
02S34E10DBBB01	W22	Qal	11-07-85	--	7.1	--	1,200	330	86	150	2	6.0	281	0
	W22		08-28-95	3,720	7.1	11.0	1,800	520	130	270	3	6.1	345	0
02S34E11AACC01	W23	Qal	09-01-95	2,760	7.1	12.0	95	18	12	580	26	1.1	673	0
	W23		09-01-95	--	--	--	--	<.1	<.1	<.1	--	<.1	--	--
02S34E11DCCD01	W24	Qal	08-30-95	3,070	7.3	10.0	1,100	190	160	300	4	7.7	469	0
02S34E11DCDA01	W25	Qal	09-01-95	2,820	7.4	11.0	950	180	120	290	4	4.4	451	0
02S34E13CBAB01	W26	Qal	09-08-87	--	7.6	--	620	120	79	240	4	4.0	460	0
02S34E13CDDD01	W27	Qal	06-05-85	--	7.9	--	380	61	56	390	9	5.0	549	0
02S34E14ABDC01	W28	Qal	08-31-95	3,420	7.5	12.0	1,200	200	170	380	5	7.0	451	0
02S34E14CADD01	W29	Qal	08-31-95	1,950	7.2	12.0	970	270	70	100	1	3.3	400	0
02S34E23CBAA01	W32	Qal	04-25-86	--	7.7	--	1,500	310	190	680	8	7.0	405	0
02S34E24ABAB01	W33	Qal	12-20-85	--	8.3	--	270	43	40	270	7	4.0	476	0
	W33		09-01-95	1,560	7.6	10.5	410	69	57	190	4	3.9	493	0
02S34E36ACCC01	W37	Qal	08-21-87	--	7.1	--	2,100	450	230	660	6	9.0	502	0
02S34E36ACCC02	W38	Qal	08-24-87	--	7.1	--	2,100	440	240	690	7	7.0	509	0
03S34E13CDAA01	W42	Qal	05-31-85	--	7.7	--	530	140	42	27	.5	2.0	364	0
03S34E24AAAC01	W43	Kjr	06-12-86	--	7.5	--	730	95	120	160	3	6.0	492	0
03S35E18DABD01	W44	Ku	10-27-77	7,910	--	13.0	770	110	120	1,900	30	7.0	820	0
03S35E18DCBD01	W45	Kjr	12-19-45	--	--	--	67	12	9.0	--	--	--	390	0
	W45		06-28-77	2,670	8.7	10.0	17	4.8	1.3	640	67	2.0	440	0
03S35E18DCCB01	W46	Qal	06-29-77	1,070	7.8	10.0	260	60	27	150	4	2.0	380	0
03S35E19AABA01	W47	Qal	10-26-84	--	8.1	--	310	52	44	330	8	3.0	361	0
03S35E19CBDD01	W49	Qal	08-28-95	1,540	7.6	10.0	250	52	28	250	7	3.4	377	0
03S35E29ABCC01	W52	Qal	10-23-84	--	8.0	--	670	120	88	400	7	6.0	476	0
03S35E29CDBA01	W54	Kjr	10-26-84	--	8.5	--	17	5.0	1.0	420	45	1.0	517	0
03S35E32DBDA01	W56	Kjr	07-21-81	--	8.3	--	66	15	7.0	580	31	2.0	565	5
	W56		10-26-84	--	8.6	--	240	88	5.0	570	16	2.0	542	7
03S35E32DDABO1	W57	Kjr	03-31-75	--	8.3	--	100	30	6.0	490	21	--	525	28
	W57		08-30-95	1,900	8.1	11.0	160	34	17	360	13	3.2	523	0
	W57		08-30-95	--	--	--	160	34	17	360	13	3.3	--	--

Table 7. Physical properties and common-ion, trace-element, and radon concentrations in water from selected wells along the Little Bighorn River and adjacent areas, Montana (Continued)

[Location and site numbers described in text. Hydrogeologic unit: Qal, Quaternary alluvium (includes low-terrace deposits); Qth, Quaternary high-terrace deposits; Kjr, Upper Cretaceous Judith River Formation, Ku, Upper Cretaceous rocks, undifferentiated. Abbreviations: µS/cm, microsiemens per centimeter at 25 degrees Celsius; °C, degrees Celsius; mg/L, milligrams per liter; µg/L, micrograms per liter; pCi/L, picocuries per liter. Remarks: First entry is collecting agency: IHS, Indian Health Service; S, U.S. Geological Survey. Second entry is analyzing agency: CL, Commercial Laboratory; MBMG, Montana Bureau of Mines and Geology; S, U.S. Geological Survey. Third entry is quality-assurance sample: QA-B, quality-assurance sample, field blank; QA-R, quality-assurance sample, replicate. Symbols: --, no data; <, less than minimum reporting level]

Alkalinity, onsite[1] (mg/L as $CaCO_3$)	Sulfate, dissolved (mg/L as SO_4)	Chloride, dissolved (mg/L as Cl)	Fluoride, dissolved (mg/L as F)	Silica, dissolved (mg/L as SiO_2)	Solids, sum of constituents, dissolved (mg/L)	Arsenic, dissolved (µg/L as As)	Barium, dissolved (µg/L as Ba)	Beryllium, dissolved (µg/L as Be)	Boron, dissolved (µg/L as B)	Cadmium, dissolved (µg/L as Cd)	Chromium, dissolved (µg/L as Cr)	Cobalt, dissolved (µg/L as Co)	Site number
358	180	12	--	--	612	--	--	--	--	--	--	--	W7
390	3,100	190	--	--	4,910	--	--	--	--	--	--	--	W9
378	880	21	0.3	28	1,650	<1	10	<1	660	2	<10	<6	W10
388	370	8.0	--	--	891	--	--	--	--	--	--	--	W13
309	1,600	36	--	--	2,480	--	--	--	--	--	--	--	W16
340	1,800	29	--	--	2,920	--	--	--	--	--	--	--	W17
361	1,800	29	.3	27	2,890	<1	9	5	1,100	<3	<20	<9	W17
390	4,000	330	.5	27	6,420	--	<100	<10	940	<1	1	<1	W19
230	1,200	40	--	--	1,910	--	--	--	--	--	--	--	W22
283	1,900	98	.3	23	3,120	<1	12	<2	440	<3	<20	<9	W22
551	830	13	.3	17	1,800	<1	<3	3	490	<3	<20	<9	W23
--	.2	<.1	<.1	--	--	<1	<100	<10	20	<1	<1	<1	W23
384	1,400	38	.4	26	2,360	<1	13	<2	950	<3	<20	<9	W24
370	1,200	39	.2	21	2,090	--	16	<1	540	<2	<10	30	W25
377	740	18	--	--	1,420	--	--	--	--	--	--	--	W26
450	730	12	--	--	1,530	--	--	--	--	--	--	--	W27
370	1,600	58	.4	22	2,660	<1	12	4	920	<3	<20	<9	W28
328	810	6.7	.3	16	1,480	<1	11	2	570	<1	<5	<3	W29
332	2,500	97	--	--	3,930	--	--	--	--	--	--	--	W32
390	430	12	--	--	1,030	--	--	--	--	--	--	--	W33
404	440	7.6	.3	18	1,030	4	18	1	530	<1	<5	<3	W33
411	3,000	130	--	--	4,770	--	--	--	--	--	--	--	W37
417	3,000	130	--	--	4,760	--	--	--	--	--	--	--	W38
298	270	6.0	--	--	670	--	--	--	--	--	--	--	W42
403	650	25	--	--	1,300	--	--	--	--	--	--	--	W43
670	3,800	94	.8	11	6,450	--	--	--	--	--	--	--	W44
378	950	32	--	11	--	--	--	--	--	--	--	--	W45
380	940	26	.2	9.2	1,850	--	--	--	--	--	--	--	W45
310	270	8.3	.3	12	717	--	--	--	--	--	--	--	W46
296	660	26	--	--	1,290	--	--	--	--	--	--	--	W47
309	460	16	.3	16	1,010	--	18	<.5	590	<1	<5	3	W49
390	1,100	14	--	--	1,950	--	--	--	--	--	--	--	W52
432	480	14	--	--	1,180	--	--	--	--	--	--	--	W54
471	790	14	--	--	1,680	--	--	--	--	--	--	--	W56
456	950	14	--	--	1,910	--	--	--	--	--	--	--	W56
510	610	20	--	--	--	--	--	--	--	--	--	--	W57
428	530	10	.6	11	1,220	<1	12	<.5	840	<1	<5	<3	W57
--	520	10	.6	11	1,210	<1	12	1	830	<1	<5	<3	W57

Table 7. Physical properties and common-ion, trace-element, and radon concentrations in water from selected wells along the Little Bighorn River and adjacent areas, Montana (Continued)

[Location and site numbers described in text. Hydrogeologic unit: Qal, Quaternary alluvium (includes low-terrace deposits); Qth, Quaternary high-terrace deposits; Kjr, Upper Cretaceous Judith River Formation, Ku, Upper Cretaceous rocks, undifferentiated. Abbreviations: µS/cm, microsiemens per centimeter at 25 degrees Celsius; °C, degrees Celsius; mg/L, milligrams per liter; µg/L, micrograms per liter; pCi/L, picocuries per liter. Remarks: First entry is collecting agency: IHS, Indian Health Service; S, U.S. Geological Survey. Second entry is analyzing agency: CL, Commercial Laboratory; MBMG, Montana Bureau of Mines and Geology; S, U.S. Geological Survey. Third entry is quality-assurance sample: QA-B, quality-assurance sample, field blank; QA-R, quality-assurance sample, replicate. Symbols: --, no data; <, less than minimum reporting level]

Copper, dissolved (µg/L as Cu)	Iron, dissolved (µg/L as Fe)	Lead, dissolved (µg/L as Pb)	Lithium, dissolved (µg/L as Li)	Manganese, dissolved (µg/L as Mn)	Molybdenum, dissolved (µg/L as Mo)	Nickel, dissolved (µg/L as Ni)	Selenium, dissolved (µg/L as Se)	Silver, dissolved (µg/L as Ag)	Strontium, dissolved (µg/L as Sr)	Vanadium, dissolved (µg/L as V)	Zinc, dissolved (µg/L as Zn)	Radon-222, total (pCi/L)	Remarks	Site number
--	600	--	--	50	--	--	--	--	--	--	--	--	IHS, CL	W7
--	--	--	--	300	--	--	--	--	--	--	--	--	IHS, CL	W9
<20	37	30	120	24	30	<20	3	5.0	2,500	<12	9	680	S, S	W10
--	<100	--	--	80	--	--	--	--	--	--	--	--	IHS, CL	W13
--	--	--	--	--	--	--	--	--	--	--	--	--	IHS, CL	W16
--	550	--	--	190	--	--	--	--	--	--	--	--	IHS, CL	W17
<30	37	<30	170	280	<30	<30	5	<3	4,100	<18	20	--	S, S	W17
65	40	<2	310	<10	7	4	--	<2	7,100	4	<10	--	S, S	W19
--	310	--	--	<50	--	--	--	--	--	--	--	--	IHS, CL	W22
<30	720	<30	140	26	<30	<30	<2	<3	3,900	<18	<9	826	S, S	W22
<30	<9	<30	78	21	<30	<30	<1	<3	180	<18	21	--	S, S	W23
<1	<10	<1	<10	<10	1	<1	<1	<1	<10	<1	<10	--	S, S, QA-B	W23
<30	70	<30	170	240	<30	<30	18	<3	2,700	<18	33	[2]650	S, S	W24
<20	7,700	<20	88	440	<20	<20	--	<2	1,800	<12	12	--	S, S	W25
--	--	--	--	--	--	--	--	--	--	--	--	--	IHS, CL	W26
--	1,000	--	--	210	--	--	--	--	--	--	--	--	IHS, CL	W27
<30	280	<30	180	130	<30	<30	17	<3	2,900	<18	31	--	S, S	W28
<10	150	<10	100	63	<10	<10	14	<1	2,300	<6	4	[2]650	S, S	W29
--	210	--	--	<50	--	--	--	--	--	--	--	--	IHS, CL	W32
--	2,200	--	--	170	--	--	--	--	--	--	--	--	IHS, CL	W33
<10	2,600	<10	71	220	<10	<10	<1	<1	880	<6	14	--	S, S	W33
--	--	--	--	--	--	--	--	--	--	--	--	--	IHS, CL	W37
--	--	--	--	--	--	--	--	--	--	--	--	--	IHS, CL	W38
--	<100	--	--	<50	--	--	--	--	--	--	--	--	IHS, CL	W42
--	2,300	--	--	130	--	--	--	--	--	--	--	--	IHS, CL	W43
--	20	--	600	130	--	--	--	--	--	--	--	--	S, MBMG	W44
--	1,000	--	--	--	--	--	--	--	--	--	--	--	S, S	W45
--	90	--	140	<10	--	--	--	--	--	--	--	--	S, S	W45
--	340	--	40	90	--	--	--	--	--	--	--	--	S, MBMG	W46
--	300	--	--	<50	--	--	--	--	--	--	--	--	IHS, CL	W47
<10	1,400	<10	120	69	30	<10	--	<1	1,100	<6	<3	787	S, S	W49
--	6,500	--	--	90	--	--	--	--	--	--	--	--	IHS, CL	W52
--	<100	--	--	<50	--	--	--	--	--	--	--	--	IHS, CL	W54
--	40	--	--	40	--	--	--	--	--	--	--	--	IHS, CL	W56
--	<100	--	--	<50	--	--	--	--	--	--	--	--	IHS, CL	W56
--	900	--	--	--	--	--	--	--	--	--	--	--	IHS, CL	W57
<10	210	<10	51	31	10	<10	<1	<1	680	<6	<3	--	S, S	W57
<10	210	10	52	31	<10	<10	--	<1	680	<6	<3	--	S, S, QA-R	W57

Table 7. Physical properties and common-ion, trace-element, and radon concentrations in water from selected wells along the Little Bighorn River and adjacent areas, Montana (Continued)

Location number	Site number	Hydro-geologic unit	Date	Specific conductance, onsite (µS/cm)	pH, onsite (standard units)	Temperature, water, onsite (°C)	Hardness, total (mg/L as $CaCO_3$)	Calcium, dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)	Sodium, dissolved (mg/L as Na)	Sodium adsorption ratio	Potassium, dissolved (mg/L as K)	Bicarbonate, onsite[1] (mg/L as HCO_3)	Carbonate, onsite[1] (mg/L as CO_3)
04S35E04AACC01	W59	Qal	07-21-81	--	7.2	--	510	82	75	99	2	7.0	525	0
	W59		08-30-95	968	7.3	14.0	400	68	55	51	1	5.2	428	0
04S35E04ABAB01	W60	Kjr	08-03-89	--	8.7	--	--	4.0	<1.0	620	--	2.0	582	0
04S35E05ACAA01	W64	Kjr	10-31-84	--	8.8	--	12	3.0	1.0	370	47	2.0	502	14
04S35E05CDCC01	W65	Kjr	03-28-86	--	8.2	--	43	14	2.0	210	14	2.0	414	0
	W65		08-30-95	1,040	7.6	11.0	170	41	16	150	5	4.4	357	0
04S35E09DDD 01	W71	Qal	04-22-91	--	7.4	--	600	130	64	120	2	4.0	462	0
04S35E16CCCC01	W76	Qal	08-31-95	2,560	7.3	10.0	930	220	93	230	3	8.6	540	0
04S35E16DDDD01	W77	Qal	04-23-75	--	8.0	--	620	150	56	150	3	--	403	0
05S35E03CC 01	W85	Kjr	08-26-53	--	8.8	13.0	3	1.0	.10	320	82	.8	494	32
05S35E03CCBC01	W86	Qal	08-29-95	1,530	7.8	11.0	360	68	45	200	5	3.2	436	0
05S35E16AADC01	W90	Kjr	05-02-85	--	7.7	--	260	59	28	210	6	5.0	405	0
05S35E27BADC01	W94	Kjr	08-31-95	1,410	8.6	12.0	17	5.3	.77	300	32	1.4	393	14
05S35E34ABBB01	W96	Kjr	10-26-85	--	8.6	--	22	7.0	1.0	520	49	2.0	493	19
05S35E34DBBB01	W98	Kjr	10-09-85	--	8.6	--	30	7.0	3.0	430	34	2.0	522	14
06S35E11ACBB01	W102	Kjr	05-31-85	--	8.2	--	120	30	12	93	4	2.0	325	0
06S35E12ACBB01	W105	Kjr	01-06-86	--	8.4	--	120	26	13	200	8	2.0	315	1
06S35E13CDCB01	W114	Kjr	10-09-85	--	7.6	--	310	73	31	360	9	4.0	542	0
06S35E14DCAA01	W116	Qal	08-29-95	1,340	7.4	9.0	600	110	78	82	1	2.3	438	0
	W116		08-29-95	--	--	--	550	100	73	79	1	2.1	--	--
06S35E22ABCC01	W117	Qal	04-05-77	--	7.5	--	770	150	94	200	3	4.0	439	0
06S35E24CACD02	W123	Kjr	07-07-86	--	7.8	--	320	67	38	230	6	4.0	418	0
06S35E29BABB01	W126	Qal	12-02-85	--	7.4	--	610	150	56	53	.9	3.0	315	0
06S35E31CBCB01	W129	Ku	11-08-86	--	7.7	--	840	170	100	440	7	3.0	495	0
06S35E35DDBC01	W131	Qal	07-07-88	--	7.3	--	1,500	270	210	280	3	4.0	433	0
06S35E35DDBC02	W132	Qal	08-31-95	4,330	7.1	13.0	2,000	360	270	390	4	6.0	505	0
	W132		08-31-95	--	--	--	2,000	370	250	360	4	6.1	--	--
06S35E36BCBC02	W134	Qal	07-09-85	--	7.6	--	1,200	200	180	350	4	3.0	588	0
07S34E11CBDD01	W141	Ku	01-27-86	--	7.6	--	110	26	10	290	12	4.0	427	0
07S34E12ABBB01	W142	Qal	09-01-87	--	8.1	--	440	63	68	170	3	2.0	370	0
07S34E12ABBB02	W143	Qal	07-16-81	--	7.4	--	400	88	44	130	3	4.0	298	0
07S34E15CBDA01	W144	Qal	08-05-86	--	7.7	--	590	110	77	74	1	3.0	536	0
07S35E11ACAA02	W151	Qal	04-22-75	--	7.4	--	830	140	120	250	4	--	622	0
07S35E11DBCB01	W154	Qal	10-25-84	--	7.6	--	680	130	88	130	2	4.0	488	0
07S35E23ABCC01	W157	Kjr	05-30-86	--	8.1	--	120	27	13	170	7	3.0	427	0
07S35E36CBDB01	W160	Kjr	07-30-76	--	7.5	--	280	45	40	29	.8	4.0	281	0
08S35E15DDBD01	W167	Kjr	03-20-86	--	9.2	--	9	2.0	1.0	290	42	1.0	449	60
	W167		08-31-95	1,160	9.3	10.0	3	.8	.17	260	70	.7	459	69
08S35E28ABAC01	W174	Qal	08-29-95	469	7.6	9.0	230	60	19	6.4	.2	.9	252	0
09S34E01CDBB01	W182	Qal	08-29-95	1,350	7.1	11.0	670	170	59	64	1	5.1	513	0
09S35E04BBBA01	W186	Ku	09-05-95	--	--	--	--	--	--	--	--	--	--	--
09S35E12BABA01	W190	Qal	10-18-86	--	--	--	730	99	120	150	3	4.0	376	0
	W190		08-29-95	1,800	7.5	9.5	710	120	100	160	3	3.6	652	0

[1]Alkalinity was determined onsite by incremental titration by the USGS during sample collection in 1995. Alkalinity was determined in the laboratory by fixed-end point methods on other dates by the USGS. Alkalinity was determined by unknown methods for all samples not collected by the USGS.
[2]Radon sample was collected on 10-10-95.

Table 7. Physical properties and common-ion, trace-element, and radon concentrations in water from selected wells along the Little Bighorn River and adjacent areas, Montana (Continued)

Alkalinity, onsite[1] (mg/L as $CaCO_3$)	Sulfate, dissolved (mg/L as SO_4)	Chloride, dissolved (mg/L as Cl)	Fluoride, dissolved (mg/L as F)	Silica, dissolved (mg/L as SiO_2)	Solids, sum of constituents, dissolved (mg/L)	Arsenic, dissolved (µg/L as As)	Barium, dissolved (µg/L as Ba)	Beryllium, dissolved (µg/L as Be)	Boron, dissolved (µg/L as B)	Cadmium, dissolved (µg/L as Cd)	Chromium, dissolved (µg/L as Cr)	Cobalt, dissolved (µg/L as Co)	Site number
431	280	4.0	--	--	802	--	--	--	--	--	--	--	W59
351	180	1.4	.4	22	595	<1	34	<.5	210	<1	<5	<3	W59
477	830	26	--	--	e1,770	--	--	--	--	--	--	--	W60
425	340	18	--	--	997	--	--	--	--	--	--	--	W64
339	150	9.0	--	--	591	--	--	--	--	--	--	--	W65
292	210	16	.3	11	626	<1	20	1	270	<1	<5	<3	W65
378	470	7.0	--	--	1,030	--	--	--	--	--	--	--	W71
443	1,000	14	.2	29	1,870	--	18	<2	150	<3	<20	<9	W76
330	570	13	--	--	--	--	--	--	--	--	--	--	W77
405	230	12	--	11	e817	--	--	--	400	--	--	--	W85
357	320	27	.4	13	893	--	19	<.5	290	<1	<5	<3	W86
332	370	6.0	--	--	877	--	--	--	--	--	--	--	W90
345	340	2.3	.2	10	868	--	11	.7	320	<1	<5	<3	W94
436	630	12	--	--	1,430	--	--	--	--	--	--	--	W96
452	480	8.0	--	--	1,200	--	--	--	--	--	--	--	W98
266	49	6.0	--	--	352	--	--	--	--	--	--	--	W102
260	270	4.0	--	--	675	--	--	--	--	--	--	--	W105
444	610	16	--	--	1,360	--	--	--	--	--	--	--	W114
359	390	5.9	.3	12	898	--	14	<.5	320	<1	<5	<3	W116
--	390	5.9	.3	12	882	--	13	<.5	320	<1	<5	4	W116
360	790	23	--	--	1,480	--	--	--	--	--	--	--	W117
343	430	25	--	--	1,010	--	--	--	--	--	--	--	W123
288	420	6.0	--	--	868	--	--	--	--	--	--	--	W126
406	1,300	15	--	--	2,300	--	--	--	--	--	--	--	W129
355	1,700	29	--	--	2,720	--	--	--	--	--	--	--	W131
414	2,300	40	.3	15	3,640	<1	12	5	520	<3	<20	<9	W132
--	2,400	39	.3	15	3,700	<1	11	3	510	<3	<20	<9	W132
482	1,400	54	--	--	2,430	--	--	--	--	--	--	--	W134
350	340	4.0	--	--	882	--	--	--	--	--	--	--	W141
303	490	4.0	--	--	979	--	--	--	--	--	--	--	W142
245	410	4.0	--	--	825	--	--	--	--	--	--	--	W143
439	300	18	--	--	846	--	--	--	--	--	--	--	W144
510	820	15	--	--	--	--	--	--	--	--	--	--	W151
400	560	12	--	--	1,160	--	--	--	--	--	--	--	W154
350	130	11	--	--	562	--	--	--	--	--	--	--	W157
230	120	6.0	--	--	379	--	--	--	--	--	--	--	W160
509	120	11	--	--	726	--	--	--	--	--	--	--	W167
491	120	6.9	.5	7.5	693	<1	16	.7	1,200	<1	<5	<3	W167
207	43	.5	.2	9.0	264	--	58	<.5	50	<1	<5	3	W174
420	340	12	.4	15	920	<1	44	<.5	260	<1	<5	<3	W182
--	--	--	--	--	--	--	--	--	--	--	--	--	W186
308	730	10	--	--	1,310	--	--	--	--	--	--	--	W190
534	500	10	.3	16	1,240	<1	17	<.5	210	<1	<5	<3	W190

Table 7. Physical properties and common-ion, trace-element, and radon concentrations in water from selected wells along the Little Bighorn River and adjacent areas, Montana (Continued)

Copper, dissolved (µg/L as Cu)	Iron, dissolved (µg/L as Fe)	Lead, dissolved (µg/L as Pb)	Lithium, dissolved (µg/L as Li)	Manganese, dissolved (µg/L as Mn)	Molybdenum, dissolved (µg/L as Mo)	Nickel, dissolved (µg/L as Ni)	Selenium, dissolved (µg/L as Se)	Silver, dissolved (µg/L as Ag)	Strontium, dissolved (µg/L as Sr)	Vanadium, dissolved (µg/L as V)	Zinc, dissolved (µg/L as Zn)	Radon-222, total (pCi/L)	Remarks	Site number
--	<30	--	--	<20	--	--	--	--	--	--	--	--	IHS, CL	W59
<10	33	<10	41	6	<10	<10	<1	<1	750	<6	10	--	S, S	W59
--	--	--	--	--	--	--	--	--	--	--	--	--	IHS, CL	W60
--	500	--	--	<50	--	--	--	--	--	--	--	--	IHS, CL	W64
--	<100	--	--	<50	--	--	--	--	--	--	--	--	IHS, CL	W65
<10	300	<10	59	44	<10	<10	<1	<1	600	<6	11	--	S, S	W65
--	--	--	--	--	--	--	--	--	--	--	--	--	IHS, CL	W71
<30	2,700	<30	48	310	<30	<30	--	<3	1,800	<18	11	--	S, S	W76
--	<100	--	--	<100	--	--	--	--	--	--	--	--	IHS, CL	W77
--	--	--	--	--	--	--	--	--	--	--	--	--	S, S	W85
<10	7	<10	73	<1	<10	<10	--	1.0	1,500	<6	9	680	S, S	W86
--	340	--	--	70	--	--	--	--	--	--	--	--	IHS, CL	W90
<10	12	<10	77	25	<10	<10	--	<1	170	<6	<3	--	S, S	W94
--	220	--	--	<50	--	--	--	--	--	--	--	--	IHS, CL	W96
--	410	--	--	<50	--	--	--	--	--	--	--	--	IHS, CL	W98
--	<100	--	--	<50	--	--	--	--	--	--	--	--	IHS, CL	W102
--	1,000	--	--	80	--	--	--	--	--	--	--	--	IHS, CL	W105
--	580	--	--	60	--	--	--	--	--	--	--	--	IHS, CL	W114
<10	100	<10	74	27	<10	<10	--	<1	1,400	<6	11	660	S, S	W116
<10	96	20	74	25	<10	10	--	<1	1,300	<6	4	--	S, S, QA-R	W116
--	1,900	--	--	670	--	--	--	--	--	--	--	--	IHS, CL	W117
--	270	--	--	90	--	--	--	--	--	--	--	--	IHS, CL	W123
--	<100	--	--	<50	--	--	--	--	--	--	--	--	IHS, CL	W126
--	--	--	--	--	--	--	--	--	--	--	--	--	IHS, CL	W129
--	--	--	--	--	--	--	--	--	--	--	--	--	IHS, CL	W131
<30	330	<30	180	12	<30	<30	12	<3	4,700	<18	55	--	S, S	W132
<30	330	<30	170	12	<30	<30	14	<3	4,700	<18	52	--	S, S, QA-R	W132
--	2,700	--	--	300	--	--	--	--	--	--	--	--	IHS, CL	W134
--	120	--	--	<50	--	--	--	--	--	--	--	--	IHS, CL	W141
--	--	--	--	--	--	--	--	--	--	--	--	--	IHS, CL	W142
--	150	--	--	<20	--	--	--	--	--	--	--	--	IHS, CL	W143
--	<100	--	--	<50	--	--	--	--	--	--	--	--	IHS, CL	W144
--	7,800	--	--	100	--	--	--	--	--	--	--	--	IHS, CL	W151
--	<100	--	--	<50	--	--	--	--	--	--	--	--	IHS, CL	W154
--	390	--	--	<50	--	--	--	--	--	--	--	--	IHS, CL	W157
--	1,000	--	--	70	--	--	--	--	--	--	--	--	IHS, CL	W160
--	190	--	--	<50	--	--	--	--	--	--	--	--	IHS, CL	W167
<10	<3	<10	35	2	<10	<10	<1	<1	34	<6	5	--	S, S	W167
<10	3	<10	7	<1	<10	<10	--	<1	300	<6	<3	430	S, S	W174
<10	140	<10	55	2	10	<10	<1	<1	1,100	<6	<3	450	S, S	W182
--	--	--	--	--	--	--	--	--	--	--	--	120	S, S	W186
--	--	--	--	--	--	--	--	--	--	--	--	--	IHS, CL	W190
<10	19	<10	120	<1	20	10	3	<1	2,300	<6	4	890	S, S	W190