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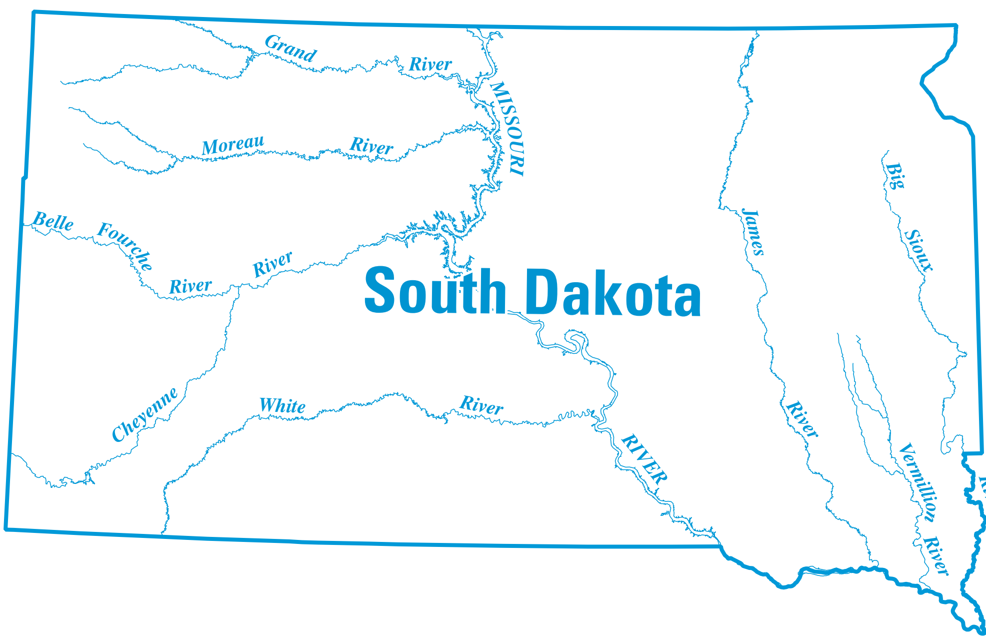
Water Resources Data
South Dakota
Water Year 2003



Water-Data Report SD-03-1

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

CALENDAR FOR WATER YEAR 2003

2002

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Water Resources Data South Dakota Water Year 2003

By Michael J. Burr, Ralph W. Teller, and Kathleen M. Neitzert

Water-Data Report SD-03-1

Prepared in cooperation with the State of South Dakota and with other agencies

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

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PREFACE

This volume of the annual hydrologic data report of South Dakota is one of a series of annual reports that document hydrologic data gathered from the U.S. Geological Survey's surface- and ground-water data-collection networks in each state, Puerto Rico, and the Trust Territories. These records of streamflow, ground-water levels, and water quality provide the hydrologic information needed by state, local, and federal agencies, and the private sector for developing and managing our Nation's land and water resources.

This report was prepared by personnel of the South Dakota District of the Water Resources Division of the U.S. Geological Survey under the supervision of D.J. Fitzpatrick, District Chief, and R.W. Teller, Chief, Hydrologic Data Collection and Analysis Section. South Dakota personnel who contributed significantly to the collecting, processing, and tabulating of the data, and typing the manuscript were:

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13. ABSTRACT *(Maximum 200 words)*

Water-resources data for the 2003 water year for South Dakota consists of records of stage, discharge, and water quality of streams; stage, contents, and water quality of lakes and reservoirs; precipitation; and water levels in wells. This report contains discharge records for 123 streamflow-gaging stations; stage and contents records for 10 lakes and reservoirs, stage for 15 streams and 3 lakes; water-quality records for 5 streamflow-gaging stations, 2 daily sediment stations, 3 wells, 11 ungaged stream sites, 2 lakes, 1 sewage lagoon, and 1 precipitation site; water levels for 6 wells; daily precipitation records at 4 sites; and 74 partial-record crest-stage gage sites. Additional water data were collected at various sites, not part of the systematic data-collection program, and are published as miscellaneous measurements and analyses. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in South Dakota.

14. SUBJECT TERMS

*South Dakota, *Hydrologic data, *Surface water, *Ground water, *Precipitation, *Water quality, Flow rate, Gaging stations, Lakes, Reservoirs, Chemical analyses, Sediments, Water temperatures, Sampling sites, Water levels, Water analyses

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Note.--Data for partial-record stations and miscellaneous sites are published in separate sections of the data report. See references at the end of this list for page numbers for these sections.

[Letters after station names designate type of data: (d) discharge, (e) elevation, gage height, or contents, (c) chemical, (b) biological, (m) microbiological, (p) pesticide, (r) precipitation, (s) sediment]

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Jorgenson River:		
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GROUND-WATER WELLS, BY COUNTY, FOR WHICH WATER LEVELS ARE PUBLISHED IN THIS VOLUME

BEADLE COUNTY
Well 442254098174501 Local number 111N62W32ADD 476
GRANT COUNTY
Well 451848096363501 Local number 121N47W6CCC 477
MEADE COUNTY
Well 441759103261202 Local number 4N6E19BAA 478
MINNEHAHA COUNTY
Well 434330096434801 Local number 103N49W16CCB 479
SHANNON COUNTY
Well 430027102311801 Local number 35N44W17CBD2 480
Well 430027102311806 Local number 35N44W17CBD 481

DISCONTINUED SURFACE-WATER STATIONS

The following surface-water stations in South Dakota have been discontinued. Surface-water stations include: daily or monthly discharge stations; daily or monthend stage stations; peak-flow only stations (crest-stage gages); and stations where water quality and/or sediment were collected on at least a quarterly basis for 1 year. Those stations with an asterisk (*) in the period of record column currently are operated as a surface-water station of another type; see index. Information regarding these stations or stations of a type not included in this list may be obtained from the District office at the address given on the back side of the title page of this report.

Station number	Station name	Contributing drainage area (mi^2)	Period of record for discontinued activity (water years)	Type of record discontinued
05050000	Bois De Sioux River near White Rock	1,160	1964-66*	Water quality/sediment
05051650	LaBelle Creek near Veblen	8.74	1988-99*	Daily discharge
05289950	Little Minnesota River tributary at Sisseton	4.21	1970-79	Peak flow
05290000	Little Minnesota River near Peever	438	1940-81, 1990-2002	Daily discharge
05290300	North Fork Whetstone River tributary near Wilmot	.96	1970-79	Peak flow
05290500	Whetstone River near Corona	170	1954-57	Daily discharge
05291000	Whetstone River near Big Stone City	389	1974-88*	Water quality/sediment
05291500	Big Stone Lake near Big Stone City (formerly "at Ortonville, MN")	--	1937-93	Stage/monthend
05292600	North Fork Yellow Bank River tributary near Stockholm	8.15	1970-79	Peak flow
05299700	Cobb Creek near Gary	70.3	1993-2002	Daily discharge
06334500	Little Missouri River at Camp Crook	1,970	1972-73*	Water quality/sediment
06354830	Lake Oahe near Kenel	--	1972	Water quality
06354845	Spring Creek tributary near Greenway	.99	1970-79	Peak flow
06354860	Spring Creek near Herreid	220	1963-86	Daily discharge
			1978	Water quality/sediment
			1989-97	Peak flow
06354880	Spring Creek near Pollock	1,530	1959-62	Daily discharge
06355400	North Fork Grand River tributary near Lodgepole	3.07	1970-79	Peak flow
06355500	North Fork Grand River near White Butte	1,190	1950-51*	Water quality/sediment
06356000	South Fork Grand River at Buffalo	148	1955-94	Daily discharge
06356050	Wide Sandy Creek near Buffalo	38.8	1956, 1958-73	Peak flow
06356150	North Jack Creek near Ludlow	1.69	1970-79	Peak flow
06356500	South Fork Grand River near Cash	1,350	1950-51*	Water quality/sediment
06356600	South Fork Grand River tributary near Bison	1.00	1970-79	Peak flow
06357000	Shadehill Reservoir at Shadehill	3,120	1960-76*	Water quality/sediment
06357500	Grand River at Shadehill	3,120	1951-88, 1991-92	Daily discharge
			1943-51	Monthly discharge
			1950-80	Water quality/sediment
06357800	Grand River at Little Eagle	5,370	1975-90*	Water quality/sediment
06358000	Grand River near Wakpala	5,510	1949-64	Daily discharge
			1912-18, 1928-48	Monthly discharge
			1950-53	Water quality/sediment
06358320	Claymore Creek near Mobridge	2.18	1956-68	Peak flow
06358350	Claymore Creek tributary near Trail City	1.98	1956-73	Peak flow
06358400	Claymore Creek tributary No. 2 near Trail City	.15	1956-73	Peak flow
06358500	Missouri River near Mobridge	208,700	1934-62	Daily discharge
			1928-34	Monthly discharge
06358520	Deadman Creek tributary near Mobridge	.30	1956-80	Peak flow

DISCONTINUED SURFACE-WATER STATIONS

Station number	Station name	Contributing drainage area (mi^2)	Period of record for discontinued activity (water years)	Type of record discontinued
06358540	Blue Blanket Creek tributary near Glenham	.62	1970-79	Peak flow
06358550	Battle Creek tributary near Castle Rock	1.57	1969-79	Peak flow
06358600	South Fork Moreau River tributary near Redig	2.33	1956, 1958-80	Peak flow
06358620	Sand Creek tributary near Redig	.06	1956, 1958-72	Peak flow
06358750	North Fork Moreau River tributary near Redig	4.00	1956, 1958-73	Peak flow
06359000	Moreau River at Bixby	1,570	1948-69 1970-73	Daily discharge Peak flow
06359300	Deep Creek tributary near Maurine	1.26	1970-79	Peak flow
06359700	Thunder Butte Creek tributary near Meadow	3.00	1970-79	Peak flow
06359800	Thunder Butte Creek tributary near Glad Valley	8.0	1970-77	Peak flow
06359850	Elm Creek tributary near Dupree	4.16	1970-79	Peak flow
06360000	Moreau River near Eagle Butte	4,320	1943-58 1950-51	Daily discharge Water quality/sediment
06360350	Little Moreau River tributary near Firesteel	2.09	1970-79	Peak flow
06360500	Moreau River near Whitehorse	4,880	1969, 1972-76, 1978-93*	Water quality/sediment
06361000	Moreau River at Promise	5,223	1935-58 1928-34 1950-51	Daily discharge Monthly discharge Water quality/sediment
06361020	Swan Lake tributary near Bowdle	27.1	1970-79	Peak flow
06394500	Beaver Creek near Burdock	1,540	1905-06, 1928-32	Monthly discharge
06394600	Hell Canyon near Jewel Cave, near Custer	Not determined	1978-80	Daily discharge
06394605	Hell Canyon near Custer	Not determined	1978-80	Daily discharge
06395000	Cheyenne River at Edgemont	7,143	1970-74*	Water quality/sediment
06396200	Fiddle Creek near Edgemont	.64	1956-80	Peak flow
06396300	Cottonwood Creek tributary near Edgemont	.09	1956-80	Peak flow
06396350	Red Canyon Creek tributary near Pringle	.20	1970-79	Peak flow
06399300	Hat Creek tributary near Ardmore	3.74	1956-79	Peak flow
06399700	Pine Creek near Ardmore	5.47	1956-75	Peak flow
06400497	Cascade Springs near Hot Springs	.47	1976-95 1996	Daily discharge Peak flow
06400500	Cheyenne River near Hot Springs	8,710	1914-20, 1943-72 1950-51	Daily discharge Water quality/sediment
06400870	Horsehead Creek near Oelrichs	108	1981-83	Daily discharge
06400900	Horsehead Creek tributary near Smithwick	1.52	1969-79	Peak flow
06401500	Cheyenne River below Angostura Dam	9,100	1968-80*	Water quality/sediment
06402000	Fall River at Hot Springs	137	1938-2001*	Daily discharge
06402100	Fall River tributary at Hot Springs	3.81	1970-79	Peak flow
06402470	Beaver Creek above Buffalo Gap	111	1991-97*	Daily discharge
06402600	Cheyenne River near Buffalo Gap	9,810	1969-80 1969-80	Daily discharge Water quality/sediment
06402990	French Creek below Custer	53.4	1990-92	Daily discharge
06402995	French Creek above Stockade, near Custer	68.7	1991-97*	Daily discharge

DISCONTINUED SURFACE-WATER STATIONS

Station number	Station name	Contributing drainage area (mi^2)	Period of record for discontinued activity (water years)	Type of record discontinued
06403000	French Creek near Custer	98	1945-47	Monthly discharge
06403500	French Creek near Fairburn	129	1945-47	Monthly discharge
06403800	Battle Creek tributary near Keystone	.63	1956-80	Peak flow
06403845	Grizzly Creek above E. Bear Falls, near Keystone	4.26	1999	Peak flow
06404000	Battle Creek near Keystone	66.0	1994*	Water quality/sediment
06404500	Battle Creek near Hermosa	173	1945-47	Monthly discharge
06404800	Grace Coolidge Creek near Hayward	7.48	1989* 1989-98	Water quality/sediment Daily discharge
06404998	Grace Coolidge Creek near Game Lodge, near Custer	25.2	1989*	Water quality/sediment
06405000	Grace Coolidge Creek near Custer	25.3	1967-76 1945-47	Daily discharge Monthly discharge
06405400	Grace Coolidge Creek near Fairburn	Not determined	1978-80	Daily discharge
06405500	Grace Coolidge Creek near Hermosa	27.5	1978-80 1945-47	Daily discharge Monthly discharge
06405800	Bear Gulch near Hayward	4.23	1989-98*	Daily discharge
06406100	Battle Creek tributary near Hermosa	3.49	1970-79	Peak flow
06406750	Sunday Gulch near Hill City	6.56	1956-69	Peak flow
06406800	Newton Fork near Hill City	8.17	1969-79	Peak flow
06406900	Palmer Creek near Hill City	13.3	1956-80	Peak flow
06406950	Horse Creek at 385, near Hill City	10.1	1972-73	Peak flow
06407000	Spring Creek near Hill City	142	1937-40	Monthly discharge
06408000	Spring Creek near Rapid City	171	1903-05, 1945-47	Monthly discharge
06408850	Silver Creek near Rochford	6.23	1969-79	Peak flow
06408860	Rapid Creek near Rochford	101	1989-94 1989-90	Daily discharge Water quality/sediment
06408900	Heeley Creek near Hill City	4.88	1969-79	Peak flow
06409000	Castle Creek above Deerfield Reservoir, near Hill City	79.2	1964-96*	Water quality/sediment
06411500	Rapid Creek below Pactola Dam	320	1969-92*	Water quality/sediment
06412000	Rapid Creek at Big Bend	332	1915-17, 1932-43*	Monthly discharge
06412200	Rapid Creek above Victoria Creek, near Rapid City	355	1989-90, 1992 1989-97*	Water quality/sediment Daily discharge
06412510	Rapid Creek above Rapid City	371	1991	Daily discharge
06412600	Cleghorn Springs main channel at Fish Hatchery	--	1988-92	Daily discharge
06412700	Cleghorn Springs south channel at Fish Hatchery, at Rapid City	--	1988-92	Daily discharge
06412800	Cleghorn Springs north channel at Fish Hatchery, at Rapid City	--	1988-92	Daily discharge
06412900	Rapid Creek below Cleghorn Springs, at Rapid City	378	1988-94	Daily discharge and water quality/sediment
06413000	Bennett Ditch at Rapid City	--	1946-50	Monthly discharge
06413200	Rapid Creek below Park Drive, at Rapid City	384	1987-89	Daily discharge and water quality/sediment
06413300	Leedy Ditch at headgate below Canyon Lake Dam, at Rapid City	--	1987-89	Daily discharge and monthly discharge

DISCONTINUED SURFACE-WATER STATIONS

Station number	Station name	Contributing drainage area (mi^2)	Period of record for discontinued activity (water years)	Type of record discontinued
06413550	Leedy Ditch at mouth, at Rapid City	--	1946-50, 1988-89	Daily discharge
06413570	Rapid Creek above Jackson Boulevard, at Rapid City	391	1987-89	Daily discharge
06413650	Lime Creek at mouth, at Rapid City	10.0	1982, 1988-2002	Daily discharge
06413660	Storybook Ditch at headgate, at Rapid City	--	1988-89	Daily discharge
06413670	Storybook Ditch at mouth, at Rapid City	--	1987-89	Daily discharge
06413700	Rapid Creek above Water Treatment Plant, at Rapid City	404	1980-82, 1987-89	Daily discharge
06413800	Deadwood Avenue Drain at mouth, at Rapid City	2.18	1981-82, 1987-90	Daily discharge
06414500	Iowa Ditch at Rapid City	--	1946-50	Monthly discharge
06414700	Rapid Creek at East Main St., at Rapid City	416	1980-82	Daily discharge
06415000	Lockhart Ditch at Rapid City	--	1946-50	Monthly discharge
06415500	Hawthorne Ditch at Rapid City	--	1981-82 1946-53	Daily discharge Monthly discharge
06416000	Rapid Creek below Hawthorne Ditch, at Rapid City	418	1980-82* 1946-53 1953	Daily discharge Monthly discharge Water quality/sediment
06416300	Meade Street Drain at Rapid City	3.15	1973-77, 1980 1980-82	Daily discharge Water quality/sediment
06416500	Murphy Ditch near Rapid City	--	1946-50	Monthly discharge
06417000	Cyclone Ditch near Rapid City	--	1946-50	Monthly discharge
06417500	South Side Ditch near Rapid City	--	1946-50	Monthly discharge
06418000	Little Giant Ditch near Rapid City	--	1946-50	Monthly discharge
06418500	Rapid Creek below Little Giant Ditch, near Rapid City	447	1946-50	Monthly discharge
06419000	Lone Tree Ditch near Rapid City	--	1946-50	Monthly discharge
06419500	St. Germain Ditch at Caputa	--	1946-50	Monthly discharge
06420000	Rapid Creek at Caputa	509	1946-50	Monthly discharge
06420500	Hammerquist Ditch near Farmingdale	--	1946-50	Monthly discharge
06421500	Rapid Creek near Farmingdale	602	1953, 1956-58, 1969-80, 1989, 1992*	Water quality/sediment
06421750	Rapid Creek tributary near Farmingdale	1.50	1970-79	Peak flow
06422000	Rapid Creek at Creston	710	1989-90 1929-32	Daily discharge Monthly discharge
06422395	Boxelder Creek at Benchmark, near Nemo	37.2	1972-73	Peak flow
06422398	Boxelder Creek at Nemo	Not determined	1978-80	Daily discharge
06422400	Estes Creek near Nemo	6.15	1969-72	Peak flow
06422500	Boxelder Creek near Nemo	96.0	1989*	Water quality/sediment
06422600	Boxelder Creek at Camp Columbus, near Nemo	Not determined	1978-80	Daily discharge
06422650	Boxelder Creek at Doty School, near Blackhawk	Not determined	1978-80	Daily discharge
06423000	Boxelder Creek at Blackhawk	128	1903-06, 1945-47	Monthly discharge
06423250	Boxelder Creek tributary at New Underwood	.14	1970-73	Peak flow
06423400	Bull Creek tributary near Wall	.39	1970-78	Peak flow
06423500	Cheyenne River near Wasta	12,800	1956-57, 1983-84*	Water quality/sediment
06424500	Elk Creek above Piedmont	49	1945-47	Monthly discharge

DISCONTINUED SURFACE-WATER STATIONS

Station number	Station name	Contributing drainage area (mi^2)	Period of record for discontinued activity (water years)	Type of record discontinued
06428500	Belle Fourche at Wyoming-South Dakota State line	3,280	1966-85*	Water quality/sediment
06429000	Belle Fourche River at Belle Fourche	3,360	1903-06	Monthly discharge
06430000	Murray Ditch at Wyoming-South Dakota State line		1954-87	Daily discharge
06430500	Redwater Creek at Wyoming-South Dakota State line	471	1969-70*	Water quality/sediment
06430540	Cox Lake Outlet near Beulah, WY	.07	1991-95	Daily discharge
06430770	Spearfish Creek near Lead	63.5	1989* 1998	Water quality/sediment Peak flow
06430800	Annie Creek near Lead	3.55	1989-93*	Water quality/sediment
06430850	Little Spearfish Creek near Lead	25.8	1989 1999*	Water quality/sediment Peak flow
06430865	Iron Creek near Lead	Not determined	1989	Water quality/sediment
06430898	Squaw Creek near Spearfish	6.95	1989-92* 1989-98	Water quality/sediment Daily discharge
06430900	Spearfish Creek above Spearfish	139	1989 1998-2001*	Water quality/sediment Peak flow
06430950	Spearfish Creek below Robinson Gulch, near Spearfish	Not determined	1989-92	Water quality/sediment
06431000	Spearfish Creek near Spearfish	157	1904-07	Monthly discharge
06432000	Spearfish Creek at Toomey Ranch, near Spearfish	179	1903	Monthly discharge
06432020	Spearfish Creek below Spearfish	204	1989* 1989-98	Water quality/sediment Daily discharge
06432200	Polo Creek near Whitewood	10.3	1956-73	Peak flow
06432230	Miller Creek near Whitewood	6.72	1956-68	Peak flow
06432250	Polo Creek tributary near Whitewood	.06	1956-67	Peak flow
06432500	Redwater Canal at Minnesala	--	1903-06	Monthly discharge
06433500	Hay Creek at Belle Fourche	121	1954-96	Daily discharge
06434000	Redwater Creek at Belle Fourche	1,020	1903-06	Monthly discharge
06434500	Inlet Canal near Belle Fourche	--	1945-94 1969-94	Daily discharge Water quality/sediment
06434800	Owl Creek tributary near Belle Fourche	3.06	1970-79	Peak flow
06435500	Belle Fourche River near Belle Fourche	4,310	1904-05	Monthly discharge
06436000	Belle Fourche River near Fruitdale	4,540	1983-84*	Water quality/sediment
06436150	Whitewood Creek above Lead	Not determined	1983-84	Water quality/sediment
06436156	Whitetail Creek at Lead	6.15	1989-94* 1989-98	Water quality/sediment Daily discharge
06436170	Whitewood Creek at Deadwood	40.6	1981-95	Daily discharge
06436190	Whitewood Creek near Whitewood	77.4	1983-84*	Water quality/sediment
06436210	Belle Fourche River below Whitewood, near Vale	Not determined	1951	Water quality/sediment
06436250	Belle Fourche River at Vale	Not determined	1983-84	Water quality/sediment
06436500	Horse Creek near Newell	67	1962-69	Daily discharge
06436700	Indian Creek near Arpan	315	1962-81 1965, 1967	Daily discharge Water quality/sediment
06436760	Horse Creek above Vale	464	1988-91*	Water quality/sediment
06436770	Dry Creek tributary near Newell	.20	1970-74	Peak flow

DISCONTINUED SURFACE-WATER STATIONS

Station number	Station name	Contributing drainage area (mi^2)	Period of record for discontinued activity (water years)	Type of record discontinued
06436800	Horse Creek near Vale	530	1962-80 1964-82	Daily discharge Water quality/sediment
06437000	Belle Fourche River near Sturgis	5,870	1954-58, 1969-98*	Water quality/sediment
06437020	Bear Butte Creek near Deadwood	16.6	1989-90, 1992-93*	Water quality/sediment
06437100	Boulder Creek near Deadwood	1.32	1956-80	Peak flow
06437200	Bear Butte Creek near Galena	47.6	1965-69*	Daily discharge
06437400	Bear Butte Creek at Sturgis	73.6	1999-2002	Daily discharge
06437500	Bear Butte Creek near Sturgis	192	1962-72* 1945-62	Daily discharge Peak flow
06437600	Belle Fourche River near Hereford	Not determined	1960	Water quality/sediment
06438000	Belle Fourche River near Elm Springs	7,210	1957-62, 1970-94*	Water quality/sediment
06438500	Cheyenne River near Plainview	21,600	1983-84*	Water quality/sediment
06439050	Cherry Creek tributary near Avance	.60	1956-80	Peak flow
06439060	Cherry Creek tributary No 2 near Avance	.11	1956-73	Peak flow
06439080	Cherry Creek tributary No 3 near Avance	4.58	1956-80	Peak flow
06439100	Beaver Creek near Faith	37.1	1956-80	Peak flow
06439300	Cheyenne River at Cherry Creek	23,900	1961-94 1971-95	Daily discharge Water quality/sediment
06439400	Plum Creek tributary near Milesville	.50	1970-79	Peak flow
06439430	Cottonwood Creek near Cherry Creek	120	1983-99	Daily discharge
06439500	Cheyenne River near Eagle Butte	24,500	1929-67 1950-53, 1973-81	Daily discharge Water quality/sediment
06440000	Missouri River at Pierre	243,500	1930-65, 1998-2000 1953-58, 1964, 1971-86, 1997-2000*	Daily discharge Water quality/sediment
06440200	South Fork Bad River near Cottonwood	250	1989-95*	Water quality/sediment
06440500	North Fork Bad River at Phillip	164	1938-44	Monthly discharge
06440700	Brady Creek tributary near Phillip	4.84	1970-78	Peak flow
06441000	Bad River near Midland	1,460	1950-51, 1956-57*	Water quality/sediment
06441110	Plum Creek below Hayes	252	1990-95*	Daily discharge and water quality/sediment
06441200	Powell Creek tributary near Fort Pierre	.40	1970-79	Peak flow
06441400	Willow Creek near Fort Pierre	102	1990	Daily discharge and water quality/sediment
06441530	Hilgers Gulch tributary near Pierre	1.33	1968-79	Peak flow
06441580	Hilgers Gulch at Pierre	6.49	1967-79	Peak flow
06441650	Mush Creek near Pierre	14.2	1956-80	Peak flow
06441670	Missouri River tributary near Pierre	.42	1956-74	Peak flow
06441750	Missouri River tributary near Canning	.20	1956-74	Peak flow
06442000	Medicine Knoll Creek near Blunt	317	1951-90 1991-97	Daily discharge Peak flow
06442050	Missouri River tributary near De Grey	1.73	1956-80	Peak flow
06442350	North Fork Medicine Creek near Vivian	47.0	1956-80	Peak flow

DISCONTINUED SURFACE-WATER STATIONS

Station number	Station name	Contributing drainage area (mi^2)	Period of record for discontinued activity (water years)	Type of record discontinued
06442380	Medicine Creek tributary near Vivian	.30	1956-73	Peak flow
06442400	Medicine Creek tributary No 2 near Vivian	9.21	1956-80	Peak flow
06442500	Medicine Creek at Kennebec	464	1955-90*	Daily discharge
06442850	Elm Creek tributary near Ree Heights	.70	1969-79	Peak flow
06442900	Elm Creek near Gann Valley	381	1988-99	Daily flow
06442950	Crow Creek near Gann Valley	670	1972-84	Daily discharge
06442960	Smith Creek tributary near Gann Valley	5.85	1972-80	Peak flow
06443000	Missouri River at Chamberlain	250,800	1945-54 1882, 1908-29	Daily discharge Monthly discharge
06445700	White River at Slim Butte	1,500	1962-70, 1991-97 1965-67	Daily discharge Water quality/sediment
06445980	White Clay Creek near Oglala	340	1966-81, 1988-99*	Daily discharge
06445990	South Fork Blacktail Creek tributary near Oelrichs	3.60	1969-79	Peak flow
06446000	White River near Oglala	340	1950-51*	Water quality/sediment
06446100	Wounded Knee Creek at Wounded Knee	82.5	1992-97*	Daily discharge
06446200	White River near Rockyford	3,000	1964-70 1971-73 1965-67	Daily discharge Peak flow Water quality/sediment
06446250	Porcupine Creek tributary near Rockyford	1.65	1968, 1970-79	Peak flow
06446300	Big Hollow Creek tributary near Scenic	2.71	1968, 1970-76	Peak flow
06446400	Cain Creek tributary at Imlay	15.8	1956-80	Peak flow
06446430	White River tributary near Conata	.17	1956-58, 1960-73	Peak flow
06446550	White River tributary near Interior	.32	1956-80	Peak flow
06446800	Cottonwood Creek near Wanblee	1.7	1971-79	Peak flow
06447000	White River near Kadoka	5,000	1950-51*	Water quality/sediment
06447200	Blackpipe Creek tributary near Norris	4.19	1971-79	Peak flow
06447490	Little White River tributary near Martin	8.9	1971-80	Peak flow
06448500	Elm Creek near Tuthill	10	1938-40	Monthly discharge
06449100	Little White River near Vetal	415	1986-89*	Water quality/sediment
06449250	Spring Creek near St. Francis	10.0	1960-74	Daily discharge
06449300	Little White River above Rosebud	630	1982-99	Daily discharge
06449400	Rosebud Creek at Rosebud	50.8	1975-97	Daily discharge
06449700	Little Oak Creek near Mission	2.58	1956-80	Peak flow
06449750	West Branch Horse Creek near Mission	6.31	1956-70	Peak flow
06449800	Little (South Fork) White River tributary near White River	9.50	1956-67	Peak flow
06450000	Little (South Fork) White River at White River	1,420	1929-32, 1938-40	Monthly discharge
06450500	Little White River below White River	1,310	1951-58*	Water quality/sediment
06451000	Little (South Fork) White River near Westover	1,640	1913-18	Monthly discharge
06451500	White River at Westover	7,850	1913-18	Monthly discharge
06451750	Cottonwood Creek tributary near Winner	4.00	1971-80	Peak flow
06452000	White River near Oacoma	9,940	1946-53, 1969, 1972-95*	Water quality
06452250	Fivemile Creek tributary near Iona	2.35	1970-79	Peak flow

DISCONTINUED SURFACE-WATER STATIONS

Station number	Station name	Contributing drainage area (mi^2)	Period of record for discontinued activity (water years)	Type of record discontinued
06452278	Lake Francis Case (Ft. Randall Reservoir) near Platte		1989-98	Daily stage
06452330	Campbell Creek near Geddes	8.37	1989-93	Peak flow
06452380	Andes Creek near Armour	Not determined	1983-2002	Water quality/sediment
06452383	Lake Andes tributary No. 3 near Armour	Not determined	1986-2002	Water quality/sediment
06452386	Lake Andes tributary No. 2 near Lake Andes	Not determined	1984-2002	Water quality/sediment
06452389	Lake Andes tributary No. 1 near Lake Andes	Not determined	1984-2002	Water quality/sediment
06452390	Lake Andes above Ravinia	Not determined	1990-2002	Water quality/sediment
06452391	Lake Andes near Ravinia	Not determined	1990-2002	Water quality/sediment
06452392	Lake Andes near Lake Andes	--	1983-86, 1988-89	Water quality/sediment
06452403	Owens Bay near Ravinia	Not determined	1990-2002	Water quality/sediment
06452406	Lake Andes above Lake Andes	Not determined	1990-2002	Water quality/sediment
06452410	Lake Andes below Lake Andes	--	1986-88	Water quality/sediment
06453000	Missouri River at Fort Randall Dam	263,500	1947-87*	Daily discharge
06453007	Missouri River above Greenwood	Not determined	1989	Stage
06453010	Missouri River at Greenwood	Not determined	1957-85, 1988	Stage
06453120	Missouri River above Choteau Creek, near Verdel, NE	Not determined	1990-2002	Water quality/sediment
06453150	Choteau Creek tributary near Tripp	.54	1970-79	Peak flow
06453200	Choteau Creek near Wagner	Not determined	1983-2002	Water quality/sediment
06453250	Choteau Creek tributary near Wagner	15.6	1970-79*	Peak flow
06453252	Choteau Creek near Dante	Not determined	1983-2002	Water quality/sediment
06453300	Choteau Creek below Avon	Not determined	1990-2002	Water quality/sediment
06463950	Rock Creek tributary near Olsonville	8.1	1970-76	Peak flow
06464000	Keya Paha River near Hidden Timber	320	1948-53	Daily discharge
06464100	Keya Paha River near Keyapaha	466	1991*	Water quality/sediment
06467500	Missouri River at Yankton	279,500	1931-95* 1957-59, 1971-72*	Daily discharge Water quality/sediment
06470980	James River near Hecla	2,188	1983-90 1985	Daily stage Water quality/sediment
06470985	Mud Lake near Houghton	--	1985-88	Water quality
06470988	Sand Lake Bay site near Houghton	--	1988-89	Water quality
06470990	Sand Lake open water site near Columbia	--	1989-93	Water quality
06470991	Sand Lake Bay site #2 near Houghton	--	1989-93	Water quality
06470992	Sand Lake near Columbia	--	1985-93	Water quality
06471000	James River at Columbia	2,481	1958, 1960-64, 1967-93*	Water quality/sediment
06471050	Elm River tributary near Leola	18.0	1956-80	Peak flow
06471350	Maple River at Frederick	423	1956-69	Peak flow
06471400	Willow Creek tributary near Leola	6.69	1956-80	Peak flow
06471450	Willow Creek tributary near Barnard	.26	1956-76	Peak flow
06471550	James River below Columbia	3,573	1989-94	Daily discharge
06471750	Snake Creek tributary near Leola	4.49	1971-78	Peak flow
06471898	Moccasin Creek near Warner	304	1976-80	Daily discharge
06471900	Moccasin Creek near Nahon	Not determined	1960-62	Water quality/sediment

DISCONTINUED SURFACE-WATER STATIONS

Station number	Station name	Contributing drainage area (mi^2)	Period of record for discontinued activity (water years)	Type of record discontinued
06472000	James River near Stratford	4,860	1950-72, 1977 1995, 1997*	Daily discharge Peak flow
06472200	Mud Creek tributary near Groton	56.7	1960-69, 1974-80	Peak flow
06472250	Mud Creek tributary No. 2 near Groton	75.8	1960-80	Peak flow
06472500	Mud Creek near Stratford	674	1955-69, 1977 1970-73	Daily discharge Peak flow
06473000	James River at Ashton	5,673	1978-90*	Water quality/sediment
06473350	South Fork Snake Creek tributary near Seneca	4.54	1971-80	Peak flow
06473400	North Fork Snake Creek tributary near Wecota	2.69	1971-79	Peak flow
06473500	South Fork Snake Creek near Athol	1,695	1950-72 1973	Daily discharge Peak flow
06473700	Snake Creek near Ashton	2,609	1956-69, 1985-89 1970-72, 1977-79 1985-87 1997	Daily discharge Peak flow Water quality/sediment Peak flow
06473750	Wolf Creek near Ree Heights	334	1960-81, 1985-89	Daily discharge
06473800	Matter Creek tributary near Orient	5.41	1956-71	Peak flow
06473820	Shaefer Creek near Orient	51.3	1956-80	Peak flow
06473850	Shaefer Creek tributary near Orient	5.17	1956-80	Peak flow
06473880	Shaefer Creek tributary near Miller	5.95	1956-80	Peak flow
06474000	Turtle Creek near Tulare	1,124	1953-56, 1965-81, 1985-89* 1985-87	Daily discharge Daily discharge Water quality/sediment
06474300	Medicine Creek near Zell	202	1960-81, 1985-89 1985-87	Daily discharge Water quality/sediment
06474500	Turtle Creek at Redfield	1,481	1946-72 1960-65 1997	Daily discharge Water quality/sediment Peak flow
06475000	James River near Redfield	9,793	1950-90 1991-97*	Daily discharge Peak flow
06475500	Dry Run near Frankfort	201	1955-69 1970-78	Daily discharge Peak flow
06475550	Dry Run tributary near Frankfort	4.19	1967-79	Peak flow
06475950	Shue Creek tributary near Yale	6.90	1968-79	Peak flow
06476000	James River at Huron	11,721	1929-32, 1949-52, 1956-93*	Monthly discharge Water quality/sediment
06476050	James River at 21st Street bridge, at Huron	Not determined	1973	Water quality/sediment
06476500	Sand Creek near Alpena	261	1950-89 1990-97	Daily discharge Peak flow
06477140	Rock Creek tributary near Roswell	5.67	1970-79	Peak flow
06477150	Rock Creek near Fulton	240	1966-72 1973-79*	Daily discharge Peak flow
06477400	Firesteel Creek tributary near Wessington Springs	.22	1968-79	Peak flow
06478000	James River near Mitchell	14,916	1967-72 1995, 1997*	Water quality/sediment Peak flow
06478050	Enemy Creek tributary near Mount Vernon	3.38	1969-79	Peak flow

DISCONTINUED SURFACE-WATER STATIONS

Station number	Station name	Contributing drainage area (mi^2)	Period of record for discontinued activity (water years)	Type of record discontinued
06478052	Enemy Creek near Mitchell	163	1976-87* 1981-93	Daily discharge Sediment
06478053	Pierre Creek near Alexandria	78.7	1982-83	Daily discharge
06478200	Coffee Creek tributary near Parkston	.81	1968-79	Peak flow
06478250	North Branch Dry Creek tributary near Parkston	3.19	1956-67	Peak flow
06478260	North Branch Dry Creek near Parkston	54.1	1956-78	Peak flow
06478280	South Branch Dry Creek near Parkston	25.8	1956-80	Peak flow
06478300	Dry Creek near Parkston	97.2	1956-80, 1989-97	Peak flow
06478320	Plum Creek near Milltown	55.2	1982-83	Daily discharge and water quality/sediment
06478390	Wolf Creek near Clayton	396	1976-88*	Daily discharge
06478400	Lonetree Creek tributary near Kaylor	3.65	1970-79	Peak flow
06478420	Lonetree Creek at Olivet	110	1982-83	Daily discharge and water quality/sediment
06478500	James River near Scotland	16,505	1956-64, 1967-73, 1975-95*	Water quality/sediment
06478513	James River near Yankton	16,794	1982-95*	Daily discharge
06478514	Beaver Creek near Yankton	145	1982-83	Daily discharge and water quality/sediment
06478530	Lake Thompson near Oldham	472	1989-95	Daily stage
06478533	Lake Thompson near Ramona	494	1987-88	Daily stage
06478535	East Fork Vermillion River near Ramona	508	1987-89, 1996-2002	Daily discharge
06478630	West Fork Vermillion River near De Smet	5.34	1970-79	Peak flow
06478650	West Fork Vermillion River tributary near Monroe	2.74	1969-79	Peak flow
06478800	Saddlerock Creek near Canton	13.0	1956-78	Peak flow
06478820	Saddlerock Creek tributary near Beresford	2.22	1956-80	Peak flow
06478840	Saddlerock Creek near Beresford	23.1	1956-70, 1972-80	Peak flow
06478950	Ash Creek near Beresford	5.00	1969-79	Peak flow
06479000	Vermillion River near Wakonda	1,676	1952-83* 1945-51 1967-72	Daily discharge Monthly discharge Water quality/sediment
06479020	Smoky Run near Irene	4.96	1969-79	Peak flow
06479136	Pickeral Lake outflow near Grenville	35.7	1999-2001	Daily discharge
06479142	Campbell Slough outflow near Waubay	48.4	1999-2001	Daily discharge
06479167	Little Rush Lake outflow near Waubay	293	1999-2001*	Daily discharge
06479200	Big Sioux River near Ortley	53.8	1956-68	Peak flow
06479230	Big Sioux River tributary near Summit	1.27	1956-67	Peak flow
06479240	Big Sioux River tributary No. 2 near Summit	.26	1956-73	Peak flow
06479260	Big Sioux River tributary No. 3 near Summit	6.61	1956-78	Peak flow
06479350	Soo Creek tributary near South Shore	1.56	1970-79	Peak flow
06479370	Big Sioux River tributary near Wallace	.50	1969-74	Peak flow
06479430	Still Lake outflow near Florence	224	1996-2001	Daily discharge

DISCONTINUED SURFACE-WATER STATIONS

Station number	Station name	Contributing drainage area (mi^2)	Period of record for discontinued activity (water years)	Type of record discontinued
06479450	Lake Kampeska (inlet/outlet) near Watertown	28.8	1994-2000	Daily discharge
			1994-2001	Daily stage
06479500	Big Sioux River at Watertown	350	1946-72	Daily discharge
			1973-79	Water quality/sediment
			1997*	Peak flow
06479515	Willow Creek near Watertown	110	1972-86	Daily discharge
			1972-74	Water quality/sediment
			1997*	Peak flow
06479529	Stray Horse Creek near Castlewood	74.5	1969-85	Daily discharge
			1972-74	Water quality/sediment
06479550	Dolph Creek tributary near Lake Norden	5.91	1970-79	Peak flow
06479640	Hidewood Creek near Estelline	164	1969-85*	Daily discharge
			1972-74	Water quality/sediment
06479750	Peg Munky Run near Estelline	25.2	1956-80	Peak flow
06479800	North Deer Creek near Estelline	48.3	1956-80	Peak flow
06479810	North Deer Creek tributary near Brookings	.33	1969-79	Peak flow
06479900	Sixmile Creek tributary near Brookings	9.78	1956-76	Peak flow
06479910	Sixmile Creek near Brookings	54	1971-80	Daily discharge
			1972-74	Water quality/sediment
06479928	Battle Creek near Nunda	158	1988-97	Daily discharge
			1988-89	Sediment
06479950	Deer Creek near Brookings	4.04	1956-80	Peak flow
06479980	Medary Creek near Brookings	200	1981-90*	Daily discharge
06480400	Spring Creek near Flandreau	63.2	1983-93	Daily discharge
06480500	Big Sioux River near Flandreau	Not determined	1929-32	Daily discharge
06480650	Flandreau Creek above Flandreau	100	1982-91*	Daily discharge
06480720	Bachelor Creek tributary near Wentworth	1.03	1969-79	Peak flow
06481000	Big Sioux River near Dell Rapids	3,004	1960-62, 1968-84*	Water quality/sediment
06481489	West Branch Skunk Creek near Hartford	80.5	1985-86	Daily discharge
06481500	Skunk Creek at Sioux Falls	613	1967-69, 1971-74	Water quality/sediment
			1949-2001*	Daily discharge
06482000	Big Sioux River at Sioux Falls	3,710	1944-60	Daily discharge
06482100	Big Sioux River at Brandon	3,774	1960-72	Daily discharge
			1967, 1970-72	Water quality/sediment
06482600	West Pipestone Creek tributary near Garretson	2.16	1969-79	Peak flow
06482610	Split Rock Creek at Corson	464	1972-74	Water quality/sediment
			1990-97*	Peak flow
06482700	Split Rock Creek near Brandon	Not determined	1967-69	Water quality/sediment
06482830	Beaver Creek near Canton	Not determined	1967, 1971-74	Water quality/sediment
06482848	Beaver Creek at Canton	124	1983-89*	Daily discharge
06482870	Little Beaver Creek tributary near Canton	.31	1956-73	Peak flow
06482875	Big Sioux River near Hudson	Not determined	1973	Water quality/sediment
06485500	Big Sioux River at Akron, IA	6,937	1966-84, 2002*	Water quality/sediment
06485550	West Union Creek near Alcester	3.48	1969-79	Peak flow
06485696	Brule Creek near Elk Point	204	1983-94	Daily discharge

INTRODUCTION

The Water Resources Division of the U.S. Geological Survey, in cooperation with Federal, State, and local agencies, obtains a large amount of data pertaining to the water resources of South Dakota each water year. These data, accumulated during many water years, constitute a valuable data base for developing an improved understanding of the water resources of the State. To make these data readily available to interested parties outside the Geological Survey, the data are published annually in this report series entitled “Water Resources Data - South Dakota.”

This report includes records on both surface and ground water in the State. Specifically, it contains: (1) Discharge records for 123 streamflow-gaging stations; (2) stage and contents records for 10 lakes and reservoirs, stage for 15 stream sites and 3 lakes; (3) water-quality records for 5 streamflow-gaging stations, 2 daily sediment stations, 3 wells, 11 ungaged stream sites, 2 lakes, 1 sewage lagoon, and 1 precipitation site; (4) water levels for 6 wells; (5) precipitation records at 4 sites; and (6) 74 partial-record crest-stage gage stations. Locations of these sites are shown in figures 4, 5, and 6. Miscellaneous hydrologic data were collected at 89 measuring sites not involved in the systematic data-collection program. The data in this report represent that part of the National Water Data System collected by the U.S. Geological Survey.

This series of annual reports for South Dakota began with the 1961 water year with a report that contained only data relating to the quantities of surface water. For the 1964 water year, a similar report was introduced that contained only data relating to water quality. Beginning with the 1975 water year, the report format was changed to present, in one volume, data on quantities of surface water, quality of surface and ground water, and ground-water levels.

Prior to introduction of this series and for several water years concurrent with it, water-resources data for South Dakota were published in U.S. Geological Survey Water-Supply Papers. Data on stream discharge and stage and on lake or reservoir contents and stage, through September 1960, were published annually under the title “Surface-Water Supply of the United States, Parts 6A and 6B.” For the 1961 through 1970 water years, the data were published in two 5-year reports. Data on chemical quality, temperature, and suspended sediment for the 1941 through 1970 water years were published annually under the title “Quality of Surface Waters of the United States,” and water levels for the 1935 through 1974 water years were published under the title “Ground-Water Levels in the United States.” The above-mentioned Water-Supply Papers may be consulted in the libraries of the principal cities of the United States and may be purchased from the Books and Open-File Reports Section, Federal Center, Box 25425, Denver Colorado 80225.

Publications similar to this report are published annually by the Geological Survey for all States. These official Survey reports have an identification number consisting of the two-letter State abbreviation, the last two digits of the water year, and the volume number. For example, this volume is identified as “U.S. Geological Survey Water-Data Report SD-03-1.” For archiving and general distribution, the reports for 1971-74 water years also are identified as water-data reports. These water-data reports are for sale in paper copy or in microfiche by the National Technical Information Service, U.S. Department of Commerce, Springfield, VA 22161. Additional information, including current prices, for ordering specific reports may be obtained from the District Chief at the address given on back of title page or by telephone (605) 355-4560.

COOPERATION

The U.S. Geological Survey and agencies of the State of South Dakota have had cooperative agreements for the collection of surface-water records since 1914, for ground-water levels since 1935, and for water-quality since 1947. Organizations that assisted in collecting the data in this report through cooperative agreements with the Survey are: South Dakota Department of Environment and Natural Resources; South Dakota Department of Transportation; South Dakota Department of Game, Fish and Parks; East Dakota Water Development District; James River Water Development District; Vermillion Basin Water Development District; West Dakota Water Development District; West River Water Development District; City of Aberdeen; City of Huron; City of Rapid City; City of Watertown; City of Sioux Falls; City of Castlewood; Custer County; Codington County; Pennington County; Lawrence County; Meade County; Rapid Valley Water Conservation District; Angostura Irrigation District; Belle Fourche Irrigation District; Lake Kampeska Water Project District; State of Wyoming; and Lac qui Parle-Yellow Bank Clean Water Partnership.

Assistance in the form of funds or services was given by the U.S. Army Corps of Engineers; U.S. Department of Agriculture, U.S. Forest Service; U.S. Department of Interior, U.S. Fish and Wildlife Service, National Park Service, Bureau of Indian Affairs, Bureau of Reclamation, Bureau of Land Management; U.S. Geological Survey, EROS Data Center; Rosebud Sioux Tribe, Sisseton-Wahpeton Sioux Tribe, Standing Rock Sioux Tribe, Ogalalla Sioux Tribe, Yankton Sioux Tribe, and Lower Brule Sioux Tribe. Organizations that supplied data are acknowledged in station descriptions.

SUMMARY OF HYDROLOGIC CONDITIONS

By R.W. Teller, L.D. Putnam, and K.M. Neitzert

Hydrologic conditions for water year 2003 were similar to last year. Precipitation and streamflows generally were below normal especially in the South Central part of the State. This followed 1993, 1995, 1997, and 2001 flooding, when several streamflow-gaging stations had peaks exceeding the 100-year recurrence interval. In the Northeast, the levels of some lakes have risen by nearly 24 feet since 1992. This year near-normal precipitation patterns were observed in this part of the State. With decreased precipitation within the Waubay Lakes Chain in Day County, Bitter Lake dropped 2.2 feet to an elevation of 1,794.4 feet on September 17, which is still about 21.6 feet higher than the lake elevation of 1,772.8 feet that existed in September 1992. These lower levels may be attributed to reduced inflows from Rush Lake. Waubay Lake dropped to an elevation of about 1,799.6 feet on September 17. This is attributed to a combination of near-normal precipitation and reduced outflows from the upper Waubay Lake system via Rush Lake into Bitter Lake. Precipitation at the Waubay National Wildlife Refuge station during April-September of 2003 was 17.52 inches, compared to 16.62 inches during the same period in 2002. The level of Lake Oahe on the Missouri River on September 30, 2003, was 5.4 feet lower than at the same time in 2002.

Table 1. Cumulative precipitation and departures from normal[1], in inches

National Weather Service Division[2]	October-December		October-March		October-June		October-September	
	Precipi-tation	Departure from normal	Precipi-tation	Departure from normal	Precipi-tation	Departure from normal	Precipi-tation	Departure from normal
Northwest	1.11	-0.86	3.94	0.31	10.38	-1.00	14.41	-1.61
North Central	1.06	-1.02	2.49	-1.42	11.09	-.67	14.76	-2.56
Northeast	2.36	-.15	3.41	-1.27	15.95	3.15	20.49	.53
Black Hills	1.92	-.96	6.24	.60	15.21	-.29	20.09	-1.65
Southwest	1.10	-.92	3.68	-.14	11.25	-.48	14.40	-2.41
Central	.99	-1.11	2.73	-1.30	12.09	.34	15.63	-1.87
East Central	2.89	-.10	4.40	-1.09	13.03	-1.16	19.18	-2.46
South Central	1.69	-.82	3.89	-.94	12.55	-1.29	16.59	-4.01
Southeast	3.87	.64	5.75	-.14	16.29	.94	24.01	.58

[1]Based on data from 1961 to 1990.
[2]Shown in figure 1.

Precipitation

Precipitation for the water year generally was below normal in seven of the State's nine National Weather Service divisions shown in table 1. Cumulative precipitation was below normal at the end of all four quarters of the water year in four of the nine divisions. Cumulative precipitation for the nine divisions for water year 2003 ranged from 14.40 inches in the Southwest to 24.01 inches in the Southeast. Departures ranged from 0.53 inch above normal in the Northeast to -4.01 inches below normal in the South Central.

Surface Water

Annual streamflow for water year 2003, as recorded at five representative gaging stations, averaged about 77 percent of the long-term median (normal) streamflow. Annual streamflow ranged from 112 percent of the median for Castle Creek above Deerfield Reservoir, near Hill City, to 42 percent of the median for the Moreau River near Whitehorse. Monthly and annual streamflow for water year 2003 are compared with the maximum, minimum, and selected percentiles in figure 1 for the five representative gaging stations.

Streamflow at only one of the five representative gaging stations was greater than normal during water year 2003. Monthly mean flows for Castle Creek above Deerfield Reservoir, near Hill City, were above normal for 8 months of the year. Monthly mean flows for the Moreau River near Whitehorse were below normal 9 of the 12 months and significantly below normal in August. The monthly mean for September was significantly above normal. Monthly values for the White River near Oacoma were above or near normal from October through May and were below to significantly below normal the rest of the year. Streamflow for water year 2003 at the James River near Scotland was above normal from October through February and July through September. March through June were below normal. Monthly values for the Big Sioux River at Akron, Iowa, were significantly above normal from October through January, and near normal the rest of the year. Peak flows for the five representative gaging stations are shown in table 2. Peak flow during water year 2003 did not exceed the previous recorded maximum at any of the five stations.

Table 2. Comparison of water year 2003 peak streamflow to peak for long-term period

[ft^3/s, cubic feet per second]

Gaging-station number and name		Long-term period used for frequency analysis (water years)	Peak streamflow					
			Water year 2003			Long-term period		
			Peak (ft^3/s)	Date	Recurrence interval (years)	Peak	Date	Recurrence interval (years)
06360500	Moreau River near Whitehorse	1955-2002	7,530	05-04-03	3	29,700	03-23-97	36
06409000	Castle Creek above Deerfield Reservoir, near Hill City	1949-2002	288	03-31-03	15	1,120	05-22-52	>100
06452000	White River near Oacoma	1929-2002	4,820	03-21-03	<2	51,900	03-30-52	80
06478500	James River near Scotland	1929-2002	1,640	07-08-03	<2	29,400	06-23-84	70
06485500	Big Sioux River at Akron, Iowa	1929-2002	3,400	07-09-03	<2	80,800	04-09-69	>100

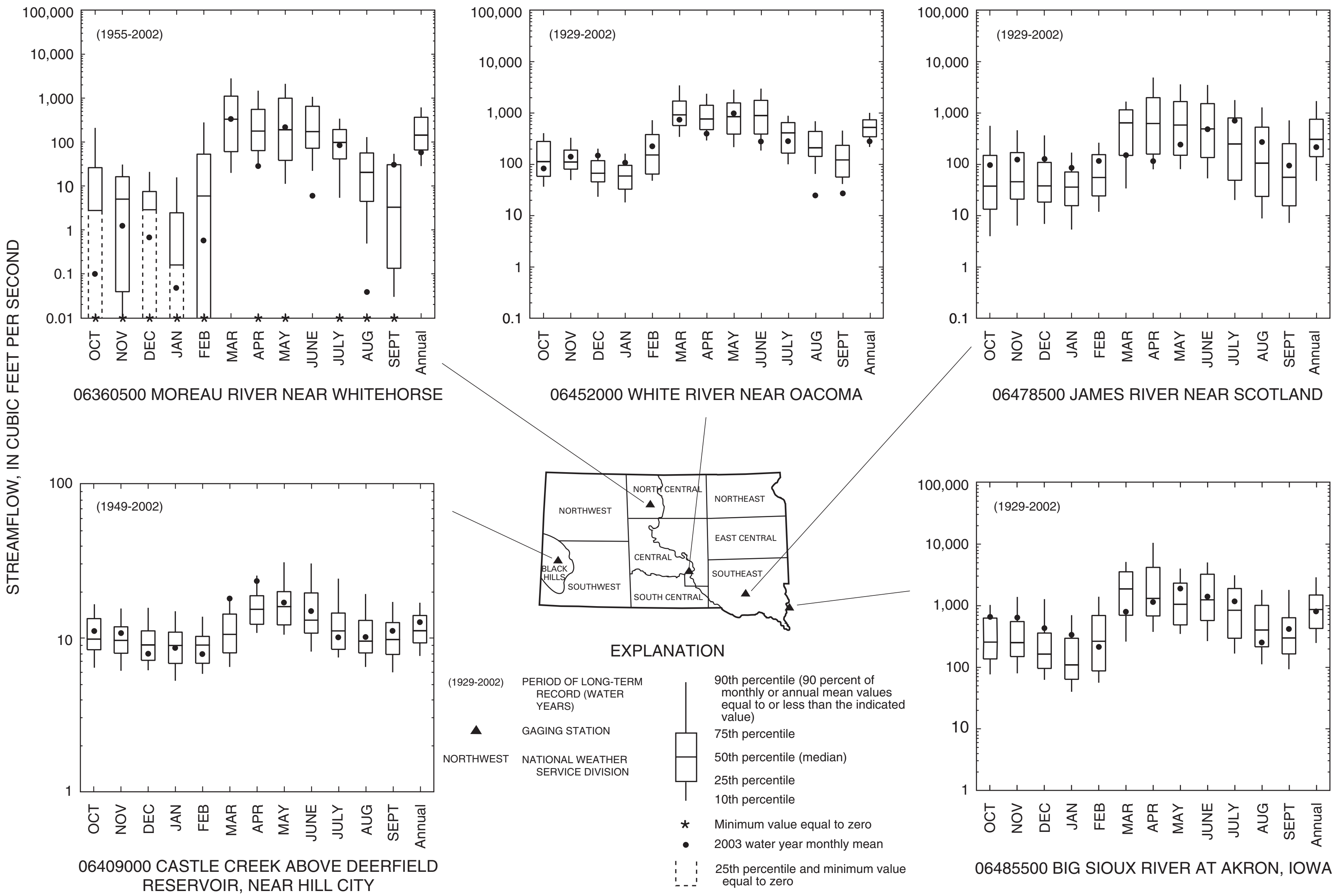


Figure 1. Comparison of 2003 monthly and annual mean to long-term distributions of monthly and annual mean flows at five representative gaging stations.

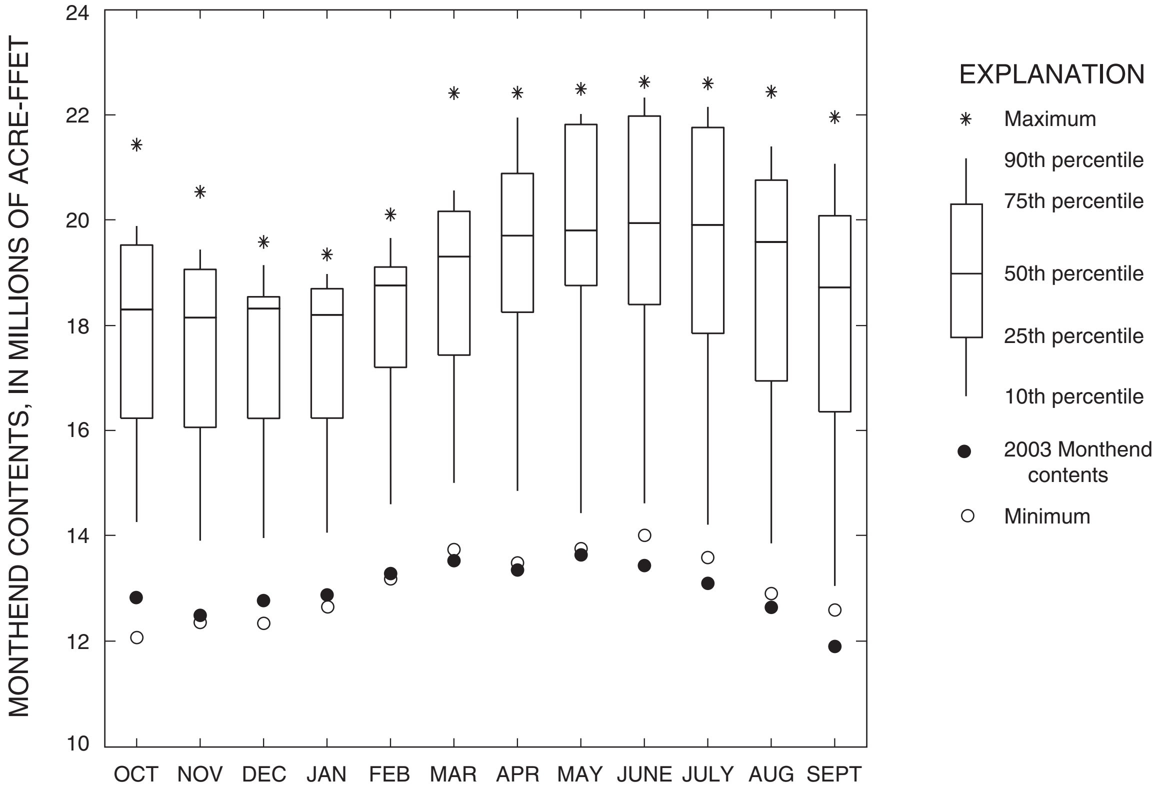


Figure 2. Comparison of monthend contents of Lake Oahe for water year 2003 with distributions of monthend contents for water years 1969-2002.

Combined storage in the four Missouri River reservoirs (Lakes Oahe, Sharpe, Francis Case, and Lewis and Clark) was 17,385,000 acre-feet on September 30,2003, a decrease of 1,021,000 acre-feet since September 30, 2002. The maximum reservoir content for Lake Oahe of 22,764,000 acre-feet was recorded on May 14,1986, and the maximum content for water year 2003 was 13,685,000 acre-feet on May 25. The highest monthend content for Lake Oahe was 13,660,000 acre-feet on May 31, or 8,893,000 acre-feet less than the record of 22,553,000 acre-feet, which occurred on June 30, 1996. Monthend contents for March through September were the lowest on record. In figure 2, monthend contents for water year 2003 are compared to the distribution of monthend contents since Lake Oahe first reached its normal maximum pool level in 1968.

Water Quality

Specific-conductance measurements of surface-water samples collected during water year 2003 for five selected stations are compared to measurements in previous years using boxplots (fig. 3). Because specific conductance varies similarly to dissolved-solids concentration, it provides a general indication of the total ionic concentration of a water sample.

Boxplots are a useful graphical technique to display water-quality data because they display the central tendency, variation, and skewness of a data set, as well as the presence or absence of unusual values. A boxplot consists of a centerline (the median) dividing a rectangle defined by the 75th and 25th percentiles. Whiskers are drawn from the ends of the box (75th and 25th percentiles) to the most extreme observation within 1.5 times the interquartile range (the distance from the 25th to the 75th percentile values) beyond the ends of the box. Values more than 1.5 interquartile ranges from the box ends are unusual and may indicate extreme hydrologic and chemical conditions or sampling and analytical errors. Observations from 1.5 to 3 interquartile ranges from the box in either direction are plotted individually with an asterisk. Observations greater than three interquartile ranges from the ends of the box are plotted with an open circle. Water year 2003 values are plotted with a closed circle to show where these data lie with respect to the historic distribution of data. The small numbers located near the month represent the total number of samples measured during that specific month over the period of record.

The boxplots of specific conductance for selected South Dakota stations (fig. 3) generally illustrate an inverse relation with discharge (fig. 1). Small median specific-conductance measurements generally occur during months that have large mean discharges. Large median specific-conductance measurements generally occur during months that have small mean discharges. Of the five selected stations shown in figure 3, the inverse relation between discharge and specific conductance is especially strong for the Moreau River near Whitehorse, the James River near Scotland, and the Big Sioux River at Akron, Iowa; not as strong for the White River near Oacoma, and may not hold true during some years; and generally does not hold true for Castle Creek above Deerfield Reservoir, near Hill City.

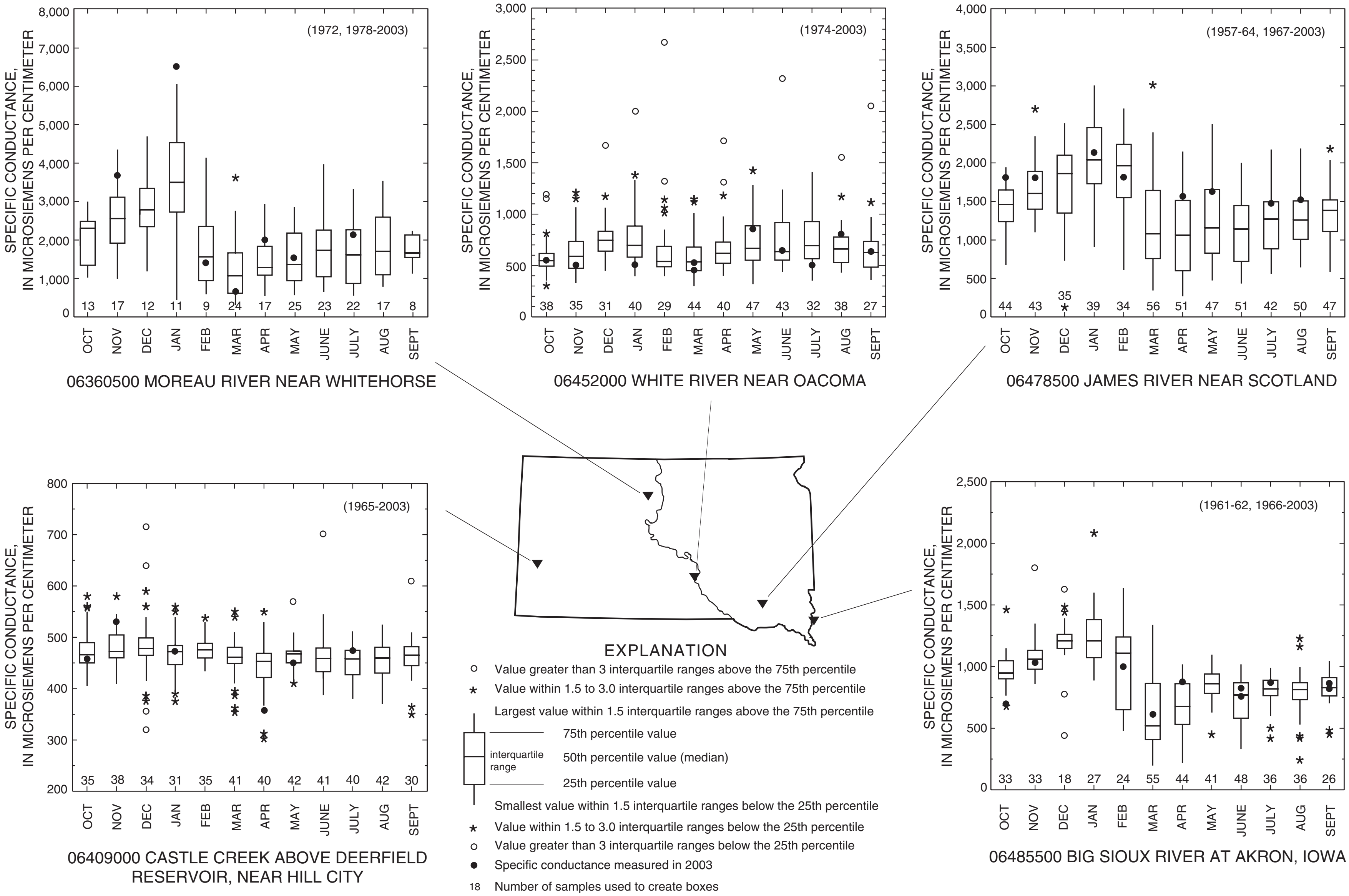


Figure 3. Comparison of 2003 specific conductance measurements to the distributions of long-term monthly values.

Some of the sites show seasonal differences in the variability of specific-conductance measurements. At some sites during some years, the discharge remains at base flow during the winter and into the spring. During other years, the base flow during this period may be diluted by the melting of ice and snow and by seasonal precipitation. This may explain the large variability of specific-conductance measurements at some sites during the winter and spring months. Small variability in specific-conductance measurements often occurs during the months of August through November when base-flow conditions may occur.

Specific-conductance measurements at the five selected stations ranged from as little as 358 microsiemens per centimeter for the April sample at the station on Castle Creek above Deerfield Reservoir, near Hill City to as much as 6,480 microsiemens per centimeter for the January sample at the station on the Moreau River near Whitehorse.

During water year 2003 for the three selected stations west of the Missouri River, patterns of specific-conductance measurements were variable and generally were associated with near-normal streamflow conditions for the station Castle Creek above Deerfield Reservoir, near Hill City and below-normal streamflow conditions for the stations Moreau River near Whitehorse and White River near Oacoma. The station on Castle Creek above Deerfield Reservoir, near Hill City probably is representative of small streams draining the Black Hills that have flows dominated by ground-water discharge. There is very little variability in specific-conductance measurements at this site due to the large contribution of ground-water discharge to the streamflow. Long-term monthly median specific conductances range from 454 microsiemens per centimeter for April to 480 microsiemens per centimeter for December. Because there is little variability in long-term specific-conductance measurements at this site, unusually large or small measurements in a given year may appear as very extreme values relative to the long-term distributions, even though the differences between the measurements and the long-term medians are relatively small in terms of specific-conductance units. During fall and winter months in water year 2003, specific-conductance measurements generally were within 5 percent of long-term medians, and were made during near-normal base-flow conditions. A notable exception to this pattern was the November 12 specific-conductance measurement, which was greater than the 75th percentile and was associated with near-normal base-flow conditions and active ice formation. During spring and summer months, specific-conductance measurements generally were within 5 percent of the long-term medians. A notable exception to this pattern was the April 3 specific-conductance measurement, which was a near-record-low value and was associated with above-normal streamflow conditions. The May 29 measurement was near the 25th percentile and was associated with near-normal streamflow conditions. The July 15th specific-conductance measurement was near the 75th percentile and was associated with near-normal streamflow conditions.

The station on the Moreau River near Whitehorse probably is representative of moderately large basins draining the Great Plains physiographic region (Fenneman, 1946) in northwestern South Dakota. During fall and winter months, specific-conductance measurements varied in relation to long-term medians, and generally were associated with below-normal streamflow conditions. The specific-conductance measurement on November 12, 2002, was greater than the long-term 75th percentile, and was made during below-normal base-flow conditions. The January 3, 2003, specific-conductance measurement was a record-high value for the month of January, and was made when base-flow conditions remained low. The February 24 specific-conductance measurement was near the long-term median value for the month of February, and was made on the falling limb of a small runoff event. During spring and summer months, specific-conductance measurements varied in relation to long-term medians, and generally were associated with below-normal streamflow conditions. The March 24 specific-conductance measurement was near the long-term 25th percentile and was made on the falling limb of below-normal snowmelt runoff. The April 10, May 27, and July 29 specific-conductance measurements were greater than the long-term medians and were associated with below-normal streamflow.

The station on the White River near Oacoma probably is representative of large streams draining the Great Plains physiographic region in southwestern South Dakota and also is influenced by the Sand Hills region of Nebraska. During fall and winter months in water year 2003, specific-conductance measurements generally were near or less than long-term medians and were associated with near-to-above-normal streamflow conditions. The January 6 specific-conductance measurement was less than the 25th percentile was associated with above-normal streamflow. During spring months, specific-conductance measurements were near or greater than long-term medians and generally were associated with below-normal streamflow conditions. During summer months, specific-conductance measurements varied in relation to long-term medians, and generally were associated with below-normal streamflow conditions. The July 23 specific-conductance measurement was less than the 25th percentile and was made on the falling limb of a small runoff event. The August 11 specific-conductance measurement was greater than the 75th percentile and was made during extended below-normal base-flow conditions. The September 10 specific-conductance measurement was near the long-term median, and although the measurement was made during below-normal streamflow conditions, specific conductance probably was influenced by local precipitation close to the time of the measurement.

The two selected stations east of the Missouri River (the James River near Scotland and the Big Sioux River at Akron, Iowa) probably are representative of large rivers draining the Central Lowlands physiographic region in eastern South Dakota. For the station on the James River near Scotland, during fall and winter months in water year 2003, specific-conductance measurements generally were near the long-term medians and were associated with near-normal streamflow conditions. A notable exception to this pattern was the October 9 specific-conductance measurement, which was greater than the 75th percentile, and was made near the peak of a runoff event. During the spring and summer months, the specific-conductance measurements generally were near or greater than the 75th percentiles, and generally were associated with below-normal streamflow conditions.

For the station on the Big Sioux River at Akron, water year 2003 fall and winter specific-conductance measurements generally were near or less than long-term medians and were associated with above-normal base-flow conditions. The October 8 specific-conductance measurement was a near-record low value and was associated with above-normal streamflow conditions. During the spring and summer months, specific-conductance measurements generally were greater than the long-term medians and were associated with near- or below-normal streamflow conditions. The April 23 specific-conductance measurement was greatr than the 75th percentile and was made near the peak of a runoff event.

Ground Water

During water year 2003, the U.S. Geological Survey participated with other Federal, State, and local agencies in monitoring trends in ground-water levels and selected water-quality data for about 2,000 wells in the State as part of the observation-well network and various site-specific studies. These key measurements are useful for observing short- and long-term ground-water trends as affected by climatic variations and land use. Long-term hydrographs for the six wells in the observation-well network are shown in figure 4. Water levels recorded during water year 2003 for the six wells shown on the map in figure 4 are presented in the Ground-Water Levels section of this report.

The Beadle County well in the east-central part of the State is completed in the Warren aquifer and is 110 feet deep. The Warren aquifer is a glacial aquifer consisting of sand and gravel. During most years, water levels decline during the summer, probably due to irrigation and evapotranspiration, and generally increase from fall through spring. Long-term trends show changes in water levels related to climatic variations, such as a general decline during the late 1980s and early 1990s due to below-normal precipitation. A general rise in water levels occurred in the 1990s due to above-normal precipitation. Water levels have declined about 10 feet since 1999 due to below-normal precipitation. Water levels increased about 4 feet from fall through spring in water year 2003.

The Grant County well in the northeastern part of the State is completed in the Veblen aquifer and is 132 feet deep. The Veblen aquifer is a glacial aquifer consisting of sand and gravel. Water-level variations correspond to long-term trends in precipitation. During periods of below-normal precipitation, the decline in water levels is relatively steady. During periods of above-normal precipitation, water levels rise quickly. Water levels rose about 20 feet during the wet period in the 1990s but have been declining since 1998 due to drier conditions. This water-level decline continued in water year 2003 with a decrease of about 3 feet.

The Meade County well, which is located in the western part of the State on the eastern flank of the Black Hills, is completed in the Madison aquifer and is 840 feet deep. The Madison aquifer is a bedrock aquifer consisting of fractured and karstic limestone. Water levels were at a low in 1993 following an extended dry period in the late 1980s and early 1990s. Water levels rose about 100 feet in the mid-to late 1990s during an extended period of above-normal precipitation. Water levels in most years show a steep rise in the spring with increased precipitation, snowmelt, and increased streamflow. Recharge to the aquifer occurs from infiltration of precipitation and streamflow loss as streams cross the Madison Limestone outcrop. Water levels generally decline from summer through winter because of increased evaporation in the summer, accumulation of snowpack in the winter, and less streamflow. During the above-normal precipitation years of the mid-to late 1990s, water-level rises in the spring were greater than previous years, and the decline in the summer-winter period was small. During the years since 1999, water levels have been declining because of below-normal precipitation. Water-level rises in the spring have been smaller and the declines in the summer-winter period have been greater than in the late 1990s. The general decline of water levels continued in water year 2003 with a rise in the spring and early summer of about 7 feet and a cumulative decline over the entire water year of about 6 feet.

The Minnehaha County well in the southeastern part of the State is completed in the Big Sioux aquifer and is 29 feet deep. The Big Sioux aquifer is an alluvial aquifer consisting of sand and gravel that is hydraulically connected to the Big Sioux River. Average water levels during the dry periods in the early and late 1980s were about 5 feet less than water levels during the wet periods. Water levels generally rise in the spring and decline during summer and fall with increased evapotranspiration and lower stages in the Big Sioux River. Water levels in water year 2003 followed a similar pattern with a water-level rise in the spring of about 3 feet.

The two Shannon County wells in the southwestern part of the State are completed in the Arikaree aquifer; one is 180 feet deep and the other is 835 feet deep. The Arikaree aquifer is a bedrock aquifer consisting of sandstone with interbedded siltstone and shale. Water levels in the shallow well fluctuated little between 1989 through 1993. Water levels increased from 1993 through 2000 because of above-normal precipitation, especially during the late 1990s. Water levels have steadily declined since 2000 because of below-normal precipitation. Water levels in water year 2003 were steady with declines of less than 1 foot. Water levels in the deep well generally rose slightly between 1989 and mid-1994. Sharp 1- to 1.5-feet fluctuations during 1994-96 were in response to pumping from the aquifer. Water levels during water year 2003 followed a pattern similar to water levels during 1998 through 2002 with a rise from fall through spring of about 10 feet and a decline in the summer due to pumping of about 9 feet.

DOWNSTREAM ORDER AND STATION NUMBER

Since October 1, 1950, hydrologic-station records in USGS reports have been listed in order of downstream direction along the main stream. All stations on a tributary entering upstream from a main-stream station are listed before that station. A station on a tributary entering between two main-stream stations is listed between those stations. A similar order is followed in listing stations on first rank, second rank, and other ranks of tributaries. The rank of any tributary on which a station is located with respect to the stream to which it is immediately tributary is indicated by an indention in that list of stations in the front of this report. Each indentation represents one rank. This downstream order and system of indentation indicates which stations are on tributaries between any two stations and the rank of the tributary on which each station is located.

As an added means of identification, each hydrologic station and partial-record station has been assigned a station number. These station numbers are in the same downstream order used in this report. In assigning a station number, no distinction is made between partial-record stations and other stations; therefore, the station number for a partial-record station indicates downstream-order position in a list composed of both types of stations. Gaps are consecutive. The complete 8-digit (or 10-digit) number for each station such as 06452000, which appears just to the left of the station name, includes a 2-digit part number “06” plus the 6-digit (or 8-digit) downstream order number “452000.” In areas of high station density, an additional two digits may be added to the station identification number to yield a 10-digit number. The stations are numbered in downstream order as described above between stations of consecutive 8-digit numbers.

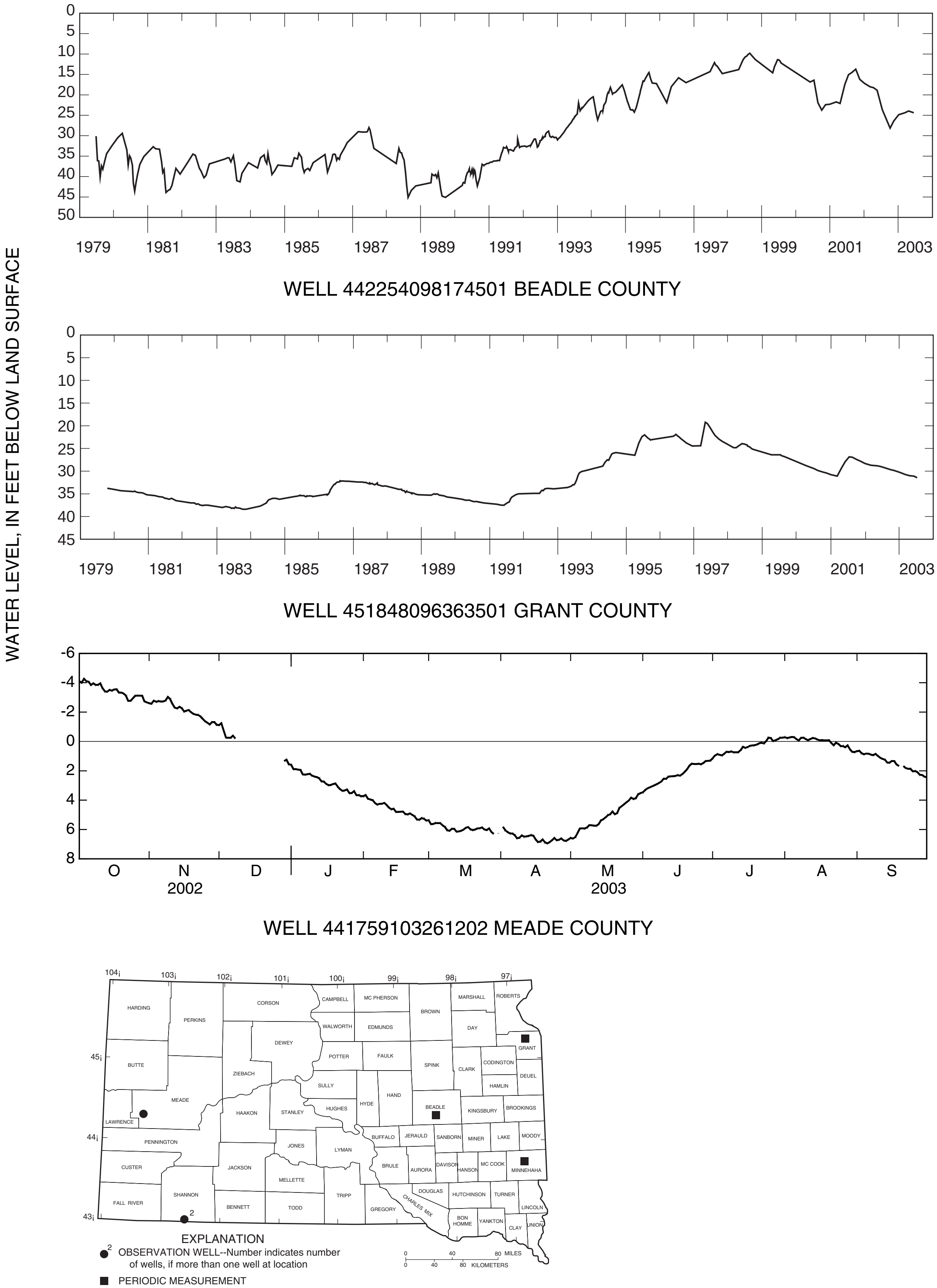


Figure 4. Water levels from selected observation wells.

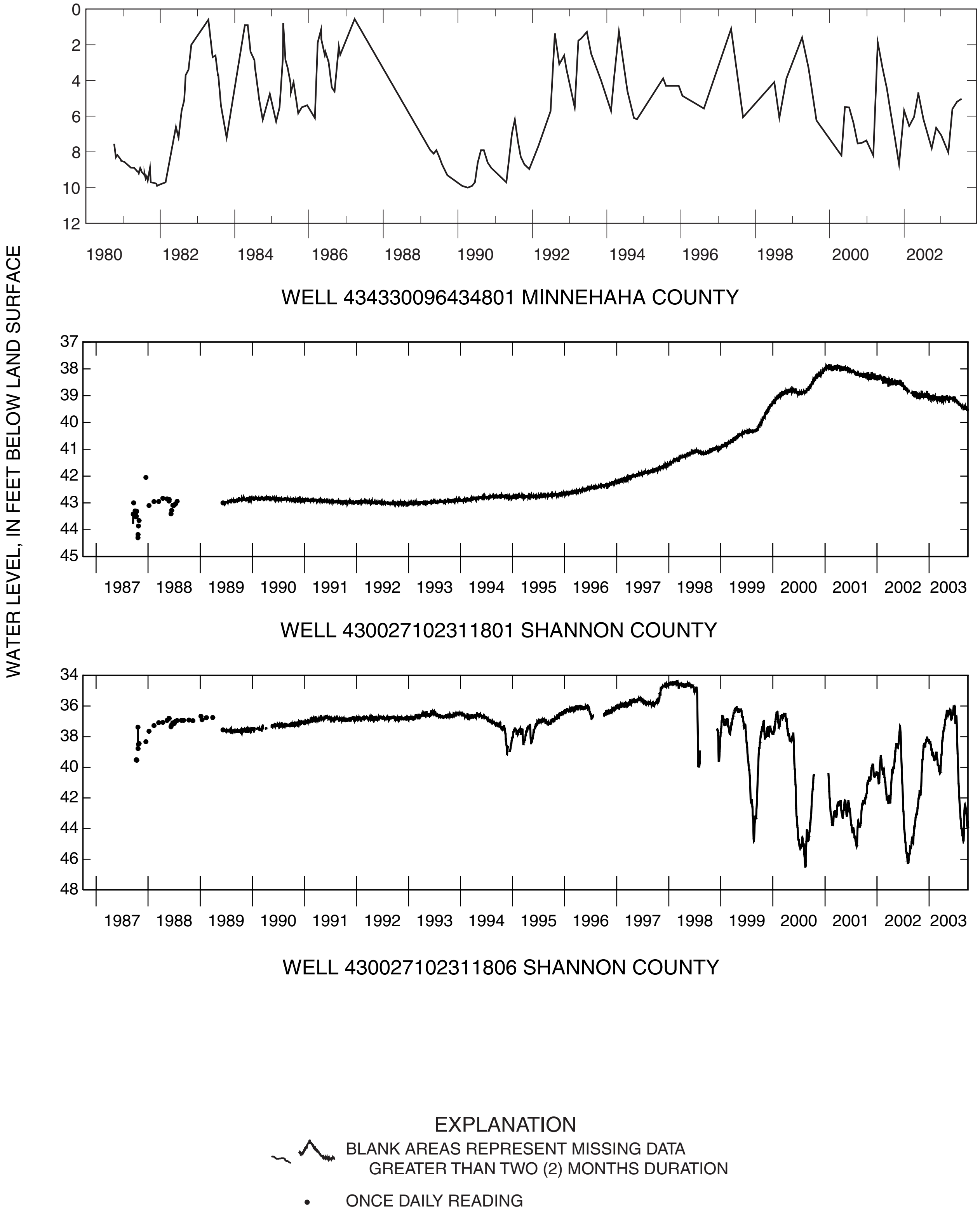
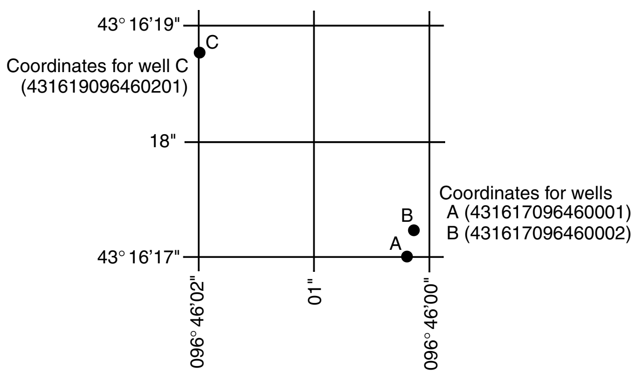


Figure 4. Water levels from selected observation wells.—Continued

NUMBERING SYSTEM FOR WELLS AND MISCELLANEOUS SITES

The USGS well and miscellaneous site-numbering system is based on the grid system of latitude and longitude. The system provides the geographic location of the well or miscellaneous site and a unique number for each site. The number consists of 15 digits. The first 6 digits denote the degrees, minutes, and seconds of latitude, and the next 7 digits denote degrees, minutes, and seconds of longitude; the last 2 digits are a sequential number for wells within a 1-second grid. In the event that the latitude-longitude coordinates for a well and miscellaneous site are the same, a sequential number such as “01,” “02,” and so forth, would be assigned as one would for wells (see figure below). The 8-digit, downstream order station numbers are not assigned to wells and miscellaneous sites where only random water-quality samples or discharge measurements are taken.



System for numbering wells and miscellaneous sites (latitude and longitude).

SPECIAL NETWORKS AND PROGRAMS

Hydrologic Benchmark Network is a network of 61 sites in small drainage basins in 39 States that was established in 1963 to provide consistent streamflow data representative of undeveloped watersheds nationwide, and from which data could be analyzed on a continuing basis for use in comparison and contrast with conditions observed in basins more obviously affected by human activities. At selected sites, water-quality information is being gathered on major ions and nutrients, primarily to assess the effects of acid deposition on stream chemistry. Additional information on the Hydrologic Benchmark Program may be accessed from http://water.usgs.gov/hbn/.

National Stream-Quality Accounting Network (NASQAN) is a network of sites used to monitor the water quality of large rivers within the Nation’s largest river basins. From 1995 through 1999, a network of approximately 40 stations was operated in the Mississippi, Columbia, Colorado, and Rio Grande River basins. For the period 2000 through 2004, sampling was reduced to a few index stations on the Colorado and Columbia Rivers so that a network of 5 stations could be implemented on the Yukon River. Samples are collected with sufficient frequency that the flux of a wide range of constituents can be estimated. The objective of NASQAN is to characterize the water quality of these large rivers by measuring concentration and mass transport of a wide range of dissolved and suspended constituents, including nutrients, major ions, dissolved and sediment-bound heavy metals, common pesticides, and inorganic and organic forms of carbon. This information will be used (1) to describe the long-term trends and changes in concentration and transport of these constituents; (2) to test findings of the National Water-Quality Assessment (NAWQA) Program; (3) to characterize processes unique to large-river systems such as storage and re-mobilization of sediments and associated contaminants; and (4) to refine existing estimates of off-continent transport of water, sediment, and chemicals for assessing human effects on the world’s oceans and for determining global cycles of carbon, nutrients, and other chemicals. Additional information about the NASQAN Program may be accessed from ***http://water.usgs.gov/nasqan/***.

The National Atmospheric Deposition Program/National Trends Network (NADP/NTN) is a network of monitoring sites that provide continuous measurement and assessment of the chemical constituents in precipitation throughout the United States. As the lead Federal agency, the USGS works together with over 100 organizations to provide a long-term, spatial and temporal record of atmospheric deposition generated from this network of 250 precipitation-chemistry monitoring sites. The USGS supports 74 of these 250 sites. This long-term, nationally consistent monitoring program, coupled with ecosystem research, provides critical information toward a national scorecard to evaluate the effectiveness of ongoing and future regulations intended to reduce atmospheric emissions and subsequent impacts to the Nation’s land and water resources. Reports and other information on the NADP/NTN Program, as well as data from the individual sites, may be accessed from *http://bqs.usgs.gov/acidrain/*.

The USGS National Water-Quality Assessment (NAWQA) Program is a long-term program with goals to describe the status and trends of water-quality conditions for a large, representative part of the Nation’s ground- and surface-water resources; to provide an improved understanding of the primary natural and human factors affecting these observed conditions and trends; and to provide information that supports development and evaluation of management, regulatory, and monitoring decisions by other agencies.

Assessment activities are being conducted in 42 study units (major watersheds and aquifer systems) that represent a wide range of environmental settings nationwide and that account for a large percentage of the Nation’s water use. A wide array of chemical constituents is measured in ground water, surface water, streambed sediments, and fish tissues. The coordinated application of comparative hydrologic studies at a wide range of spatial and temporal scales will provide information for water-resources managers to use in making decisions and a foundation for aggregation and comparison of findings to address water-quality issues of regional and national interest.

Communication and coordination between USGS personnel and other local, State, and Federal interests are critical components of the NAWQA Program. Each study unit has a local liaison committee consisting of representatives from key Federal, State, and local water-resources agencies, Indian nations, and universities in the study unit. Liaison committees typically meet semiannually to discuss their information needs, monitoring plans and progress, desired information products, and opportunities to collaborate efforts among the agencies. Additional information about the NAWQA Program may be accessed from http://water.usgs.gov/nawqa/.

The USGS National Streamflow Information Program (NSIP) is a long-term program with goals to provide framework streamflow data across the Nation. Included in the program are creation of a permanent Federally funded streamflow network, research on the nature of streamflow, regional assessments of streamflow data and databases, and upgrades in the streamflow information delivery systems. Additional information about NSIP may be accessed from http://water.usgs.gov/nsip/.

EXPLANATION OF STAGE- AND WATER-DISCHARGE RECORDS

Data Collection and Computation

The base data collected at gaging stations (fig. 5) consist of partial or continuous records of stage and measurements of discharge of streams or canals, and stage, and volume of lakes or reservoirs. In addition, observations of factors affecting the stage-discharge relation or the stage-capacity relation, weather records, and other information are used to supplement base data in determining the daily flow or volume of water in storage. Records of stage are obtained from a water-stage recorder that is either downloaded electronically in the field to a laptop computer or similar device or is transmitted using telemetry such as GOES satellite, land-line or cellular-phone modems, or by radio transmission. Measurements of discharge are made with a current meter or acoustic Doppler current profiler, using the general methods adopted by the USGS. These methods are described in standard textbooks, USGS Water-Supply Paper 2175, and the Techniques of Water-Resources Investigations of the United States Geological Survey (TWRIs), Book 3, Chapters A1 through A19 and Book 8, Chapters A2 and B2. The methods are consistent with the American Society for Testing and Materials (ASTM) standards and generally follow the standards of the International Organization for Standards (ISO).

For stream-gaging stations, discharge-rating tables for any stage are prepared from stage-discharge curves. If extensions to the rating curves are necessary to express discharge greater than measured, the extensions are made on the basis of indirect measurements of peak discharge (such as slope-area or contracted-opening measurements, or computation of flow over dams and weirs), step-backwater techniques, velocity-area studies, and logarithmic plotting. The daily mean discharge is computed from gage heights and rating tables, then the monthly and yearly mean discharges are computed from the daily values. If the stage-discharge relation is subject to change because of frequent or continual change in the physical features of the stream channel, the daily mean discharge is computed by the shifting-control method in which correction factors based on individual discharge measurements and notes by engineers and observers are used when applying the gage heights to the rating tables. If the stage-discharge relation for a station is temporarily changed by the presence of aquatic growth or debris on the controlling section, the daily mean discharge is computed by the shifting-control method.

The stage-discharge relation at some stream-gaging stations is affected by backwater from reservoirs, tributary streams, or other sources. Such an occurrence necessitates the use of the slope method in which the slope or fall in a reach of the stream is a factor in computing discharge. The slope or fall is obtained by means of an auxiliary gage at some distance from the base gage.

An index velocity is measured using ultrasonic or acoustic instruments at some stream-gaging stations and this index velocity is used to calculate an average velocity for the flow in the stream. This average velocity along with a stage-area relation is then used to calculate average discharge.

At some stations, stage-discharge relation is affected by changing stage. At these stations, the rate of change in stage is used as a factor in computing discharge.

At some stream-gaging stations in the northern United States, the stage-discharge relation is affected by ice in the winter; therefore, computation of the discharge in the usual manner is impossible. Discharge for periods of ice effect is computed on the basis of gage-height record and occasional winter-discharge measurements. Consideration is given to the available information on temperature and precipitation, notes by gage observers and hydrologists, and comparable records of discharge from other stations in the same or nearby basins.

For a lake or reservoir station, capacity tables giving the volume or contents for any stage are prepared from stage-area relation curves defined by surveys. The application of the stage to the capacity table gives the contents, from which the daily, monthly, or yearly changes are computed.

If the stage-capacity curve is subject to changes because of deposition of sediment in the reservoir, periodic resurveys of the reservoir are necessary to define new stage-capacity curves. During the period between reservoir surveys, the computed contents may be increasingly in error due to the gradual accumulation of sediment.

For some stream-gaging stations, periods of time occur when no gage-height record is obtained or the recorded gage height is faulty and cannot be used to compute daily discharge or contents. Such a situation can happen when the recorder stops or otherwise fails to operate properly, the intakes are plugged, the float is frozen in the well, or for various other reasons. For such periods, the daily discharges are estimated on the basis of recorded range in stage, prior and subsequent records, discharge measurements, weather records, and comparison with records from other stations in the same or nearby basins. Likewise, lake or reservoir volumes may be estimated on the basis of operator's log, prior and subsequent records, inflow-outflow studies, and other information.

Data Presentation

The records published for each continuous-record surface-water discharge station (stream-gaging station) consist of five parts: (1) the station manuscript or description; (2) the data table of daily mean values of discharge for the current water year with summary data; (3) a tabular statistical summary of monthly mean flow data for a designated period, by water year; (4) a summary statistics table that includes statistical data of annual, daily, and instantaneous flows as well as data pertaining to annual runoff, 7-day low-flow minimums, and flow duration; and (5) a hydrograph of discharge.

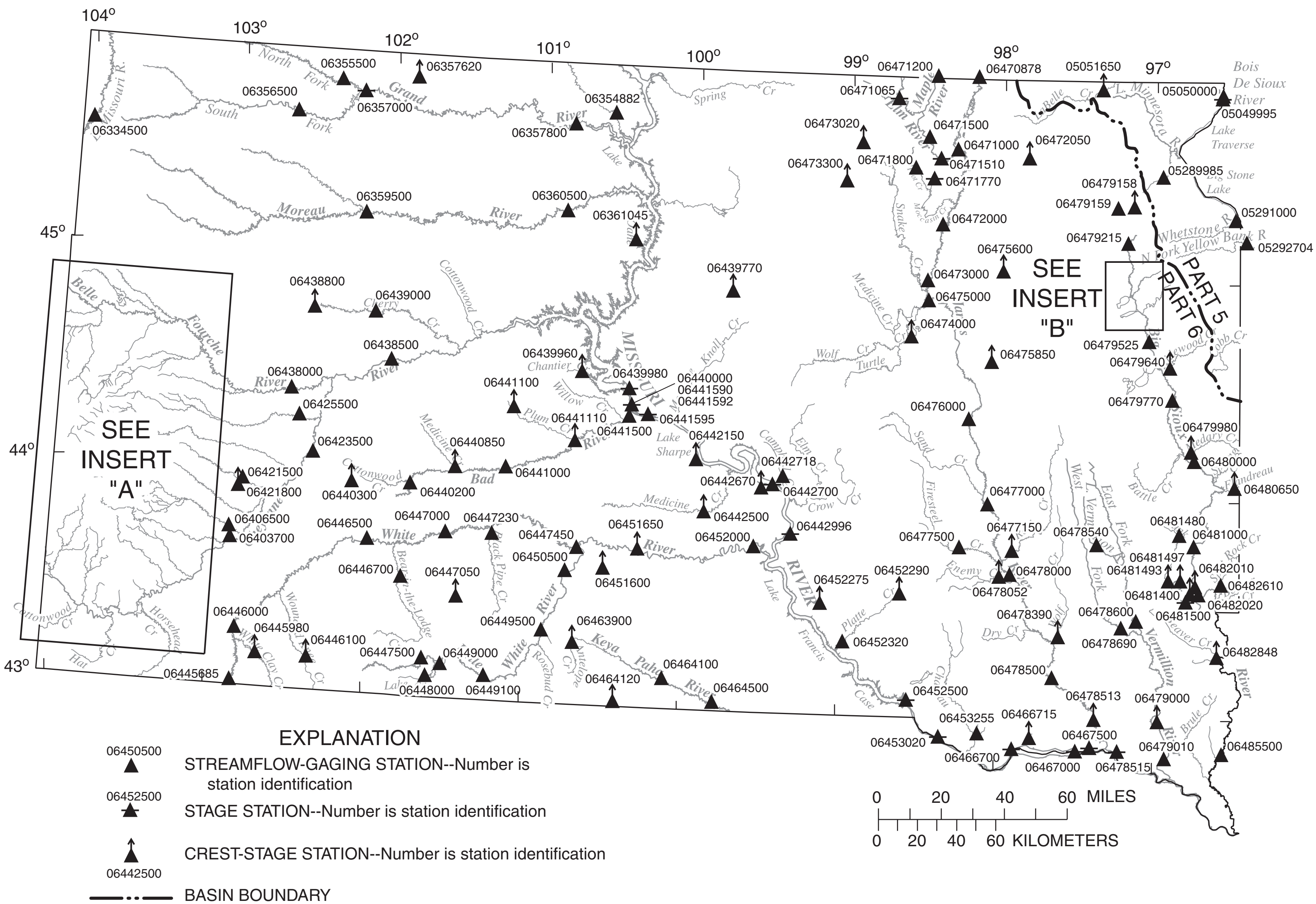


Figure 5. Location of surface-water gaging stations.

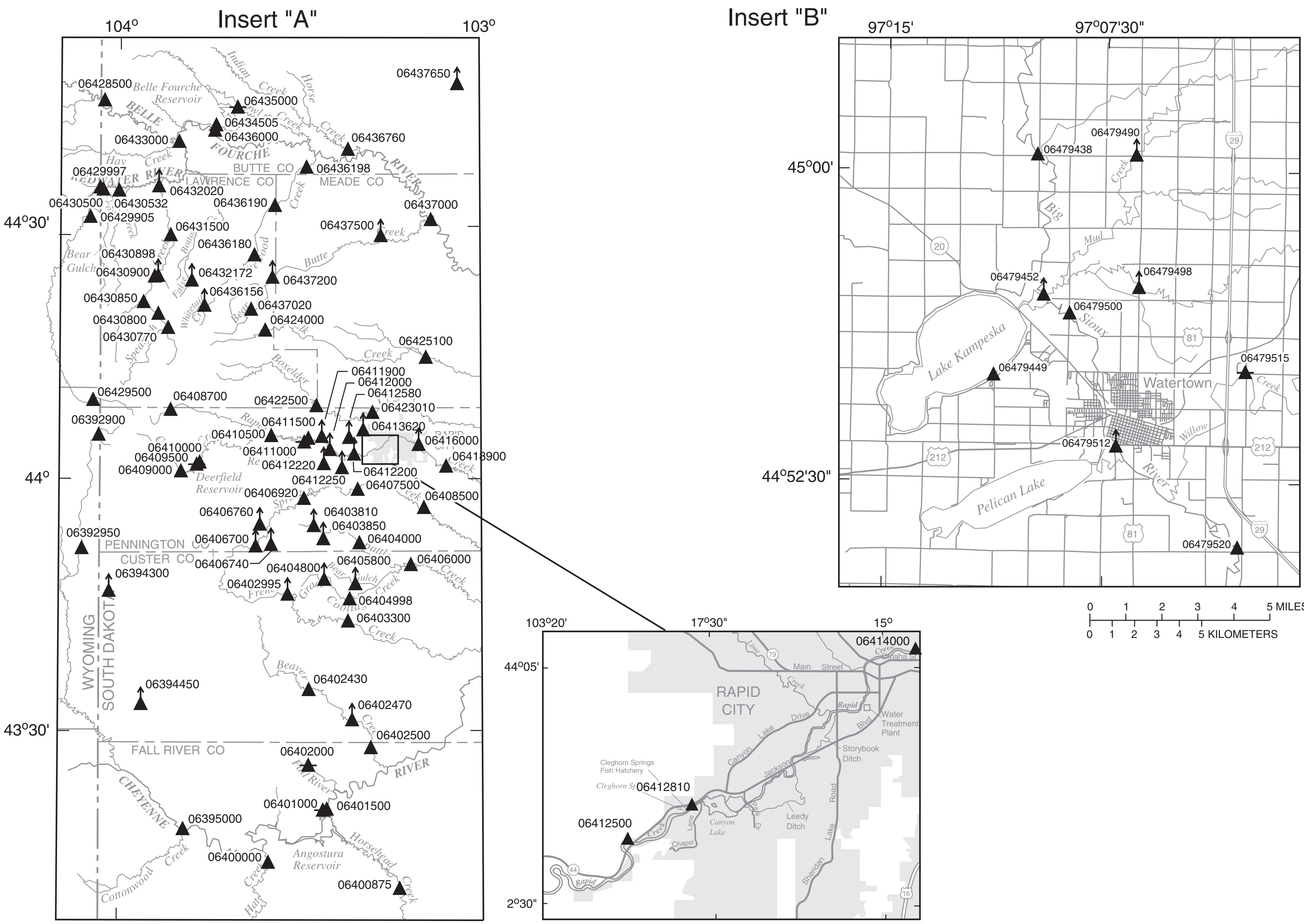


Figure 5. Location of surface-water gaging stations.—Continued

Station Manuscript

The manuscript provides, under various headings, descriptive information, such as station location; period of record; historical extremes outside the period of record; record accuracy; and other remarks pertinent to station operation and regulation. The following information, as appropriate, is provided with each continuous record of discharge or lake content. Comments follow that clarify information presented under the various headings of the station description.

LOCATION.—Location information is obtained from the most accurate maps available. The location of the gaging station with respect to the cultural and physical features in the vicinity and with respect to the reference place mentioned in the station name is given. River mileages, given for only a few stations, were determined by methods given in "River Mileage Measurement," Bulletin 14, Revision of October 1968, prepared by the Water Resources Council or were provided by the U.S. Army Corps of Engineers.

DRAINAGE AREA.—Drainage areas are measured using the most accurate maps available. Because the type of maps available varies from one drainage basin to another, the accuracy of drainage areas likewise varies. Drainage areas are updated as better maps become available.

PERIOD OF RECORD.—This term indicates the time period for which records have been published for the station or for an equivalent station. An equivalent station is one that was in operation at a time that the present station was not and whose location was such that its flow reasonably can be considered equivalent to flow at the present station.

REVISED RECORDS.—If a critical error in published records is discovered, a revision is included in the first report published following discovery of the error.

GAGE.—The type of gage in current use, the datum of the current gage referred to a standard datum, and a condensed history of the types, locations, and datums of previous gages are given under this heading.

REMARKS.—All periods of estimated daily discharge either will be identified by date in this paragraph of the station description for water-discharge stations or flagged in the daily discharge table. (See section titled Identifying Estimated Daily Discharge.) Information is presented relative to the accuracy of the records, to special methods of computation, and to conditions that affect natural flow at the station. In addition, information may be presented pertaining to average discharge data for the period of record; to extremes data for the period of record and the current year; and, possibly, to other pertinent items. For reservoir stations, information is given on the dam forming the reservoir, the capacity, the outlet works and spillway, and the purpose and use of the reservoir.

COOPERATION.—Records provided by a cooperating organization or obtained for the USGS by a cooperating organization are identified here.

EXTREMES OUTSIDE PERIOD OF RECORD.—Information here documents major floods or unusually low flows that occurred outside the stated period of record. The information may or may not have been obtained by the USGS.

REVISIONS.—Records are revised if errors in published records are discovered. Appropriate updates are made in the USGS distributed data system, NWIS, and subsequently to its Web-based National data system, NWISWeb (*http://water.usgs.gov/nwis/nwis*). Users are encouraged to obtain all required data from NWIS or NWISWeb to ensure that they have the most recent data updates. Updates to NWISWeb are made on an annual basis.

Although rare, occasionally the records of a discontinued gaging station may need revision. Because no current or, possibly, future station manuscript would be published for these stations to document the revision in a REVISED RECORDS entry, users of data for these stations who obtained the record from previously published data reports may wish to contact the District Office (address given on the back of the title page of this report) to determine if the published records were revised after the station was discontinued. If, however, the data for a discontinued station were obtained by computer retrieval, the data would be current. Any published revision of data is always accompanied by revision of the corresponding data in computer storage.

Manuscript information for lake or reservoir stations differs from that for stream stations in the nature of the REMARKS and in the inclusion of a stage-capacity table when daily volumes are given.

Peak Discharge Greater than Base Discharge

Tables of peak discharge above base discharge are included for some stations where secondary instantaneous peak discharge data are used in flood-frequency studies of highway and bridge design, flood-control structures, and other flood-related projects. The base discharge value is selected so an average of three peaks a year will be reported. This base discharge value has a recurrence interval of approximately 1.1 years or a 91-percent chance of exceedance in any 1 year.

Data Table of Daily Mean Values

The daily table of discharge records for stream-gaging stations gives mean discharge for each day of the water year. In the monthly summary for the table, the line headed TOTAL gives the sum of the daily figures for each month; the line headed MEAN gives the arithmetic average flow in cubic feet per second for the month; and the lines headed MAX and MIN give the maximum and minimum daily mean discharges, respectively, for each month. Discharge for the month is expressed in cubic feet per second per square mile (line headed CFSM); or in inches (line headed IN); or in acre-feet (line headed AC-FT). Values for cubic feet per second per square mile and runoff in inches or in acre-feet may be omitted if extensive regulation or diversion is in effect or if the drainage area includes large noncontributing areas. At some stations, monthly and (or) yearly observed discharges are adjusted for reservoir storage or diversion, or diversion data or reservoir volumes are given. These values are identified by a symbol and a corresponding footnote.

Statistics of Monthly Mean Data

A tabular summary of the mean (line headed MEAN), maximum (MAX), and minimum (MIN) of monthly mean flows for each month for a designated period is provided below the mean values table. The water years of the first occurrence of the maximum and minimum monthly flows are provided immediately below those values. The designated period will be expressed as FOR WATER YEARS __-__, BY WATER YEAR (WY), and will list the first and last water years of the range of years selected from the PERIOD OF RECORD paragraph in the station manuscript. The designated period will consist of all of the station record within the specified water years, including complete months of record for partial water years, and may coincide with the period of record for the station. The water years for which the statistics are computed are consecutive, unless a break in the station record is indicated in the manuscript.

Summary Statistics

A table titled SUMMARY STATISTICS follows the statistics of monthly mean data tabulation. This table consists of four columns with the first column containing the line headings of the statistics being reported. The table provides a statistical summary of yearly, daily, and instantaneous flows, not only for the current water year but also for the previous calendar year and for a designated period, as appropriate. The designated period selected, WATER YEARS __-__, will consist of all of the station records within the specified water years, including complete months of record for partial water years, and may coincide with the period of record for the station. The water years for which the statistics are computed are consecutive, unless a break in the station record is indicated in the manuscript. All of the calculations for the statistical characteristics designated ANNUAL (see line headings below), except for the ANNUAL 7-DAY MINIMUM statistic, are calculated for the designated period using complete water years. The other statistical characteristics may be calculated using partial water years.

The date or water year, as appropriate, of the first occurrence of each statistic reporting extreme values of discharge is provided adjacent to the statistic. Repeated occurrences may be noted in the REMARKS paragraph of the manuscript or in footnotes. Because the designated period may not be the same as the station period of record published in the manuscript, occasionally the dates of occurrence listed for the daily and instantaneous extremes in the designated-period column may not be within the selected water years listed in the heading. When the dates of occurrence do not fall within the selected water years listed in the heading, it will be noted in the REMARKS paragraph or in footnotes. Selected streamflow duration-curve statistics and runoff data also are given. Runoff data may be omitted if extensive regulation or diversion of flow is in effect in the drainage basin.

The following summary statistics data are provided with each continuous record of discharge. Comments that follow clarify information presented under the various line headings of the SUMMARY STATISTICS table.

ANNUAL TOTAL.—The sum of the daily mean values of discharge for the year.

ANNUAL MEAN.—The arithmetic mean for the individual daily mean discharges for the year noted or for the designated period.

HIGHEST ANNUAL MEAN.—The maximum annual mean discharge occurring for the designated period.

LOWEST ANNUAL MEAN.—The minimum annual mean discharge occurring for the designated period.

HIGHEST DAILY MEAN.—The maximum daily mean discharge for the year or for the designated period.

LOWEST DAILY MEAN.—The minimum daily mean discharge for the year or for the designated period.

ANNUAL 7-DAY MINIMUM.—The lowest mean discharge for 7 consecutive days for a calendar year or a water year. Note that most low-flow frequency analyses of annual 7-day minimum flows use a climatic year (April 1-March 31). The date shown in the summary statistics table is the initial date of the 7-day period. This value should not be confused with the 7-day 10-year low-flow statistic.

MAXIMUM PEAK FLOW.—The maximum instantaneous peak discharge occurring for the water year or designated period. Occasionally the maximum flow for a year may occur at midnight at the beginning or end of the year, on a recession from or rise toward a higher peak in the adjoining year. In this case, the maximum peak flow is given in the table and the maximum flow may be reported in a footnote or in the REMARKS paragraph in the manuscript.

MAXIMUM PEAK STAGE.—The maximum instantaneous peak stage occurring for the water year or designated period. Occasionally the maximum stage for a year may occur at midnight at the beginning or end of the year, on a recession from or rise toward a higher peak in the adjoining year. In this case, the maximum peak stage is given in the table and the maximum stage may be reported in the REMARKS paragraph in the manuscript or in a footnote. If the dates of occurrence of the maximum peak stage and maximum peak flow are different, the REMARKS paragraph in the manuscript or a footnote may be used to provide further information.

ANNUAL RUNOFF.—Indicates the total quantity of water in runoff for a drainage area for the year. Data reports may use any of the following units of measurement in presenting annual runoff data:

Acre-foot (AC-FT) is the quantity of water required to cover 1 acre to a depth of 1 foot and is equivalent to 43,560 cubic feet or about 326,000 gallons or 1,233 cubic meters.

Cubic feet per square mile (CFSM) is the average number of cubic feet of water flowing per second from each square mile of area drained, assuming the runoff is distributed uniformly in time and area.

Inches (INCHES) indicate the depth to which the drainage area would be covered if all of the runoff for a given time period were uniformly distributed on it.

10 PERCENT EXCEEDS.—The discharge that has been exceeded 10 percent of the time for the designated period.

50 PERCENT EXCEEDS.—The discharge that has been exceeded 50 percent of the time for the designated period.

90 PERCENT EXCEEDS.—The discharge that has been exceeded 90 percent of the time for the designated period.

Data collected at PARTIAL-RECORD STATIONS follow the information for continuous-record sites. Data for partial-record discharge stations contain the annual and period-of-record maximum stage and discharge at crest-stage stations. The table of partial-record stations is followed by the section, “DAILY PRECIPITATION STATIONS,” which is a listing of daily-precipitation tables at sites not located with continuous-record stations. The next section is titled, “MISCELLANEOUS WATER QUALITY DATA,” and consists of water-quality data from a precipitation site, operated in cooperation with the Acid Rain National Trends Network, water-quality samples obtained at sites not located with continuous-record stations. This section is followed by the section “MISCELLANEOUS TEMPERATURE MEASUREMENTS AND FIELD DETERMINATIONS” which is a listing, obtained at continuous-record or partial-record sites, of air/water temperatures, specific conductance, and discharge for which no other water-quality sample was obtained. Following is a section listing discharge measurements and/or gage heights made at sites other than continuous-record or partial-record stations titled, "MISCELLANEOUS DISCHARGE MEASUREMENTS." These measurements are made for a variety of reasons including in times of drought or flood to give better areal coverage to those events. The final section is titled, "GROUND-WATER LEVELS," for which tables of ground-water levels at selected sites are given.

Identifying Estimated Daily Discharge

Estimated daily-discharge values published in the water-discharge tables of annual State data reports are identified. This identification is shown either by flagging individual daily values with the letter "e" and noting in a table footnote, "e–Estimated," or by listing the dates of the estimated record in the REMARKS paragraph of the station description.

Accuracy of Field Data and Computed Results

The accuracy of streamflow data depends primarily on (1) the stability of the stage-discharge relation or, if the control is unstable, the frequency of discharge measurements, and (2) the accuracy of observations of stage, measurements of discharge, and interpretations of records.

The degree of accuracy of the records is stated in the REMARKS in the station description. "Excellent" indicates that about 95 percent of the daily discharges are within 5 percent of the true value; "good" within 10 percent; and "fair," within 15 percent. "Poor" indicates that daily discharges have less than "fair" accuracy. Different accuracies may be attributed to different parts of a given record.

Values of daily mean discharge in this report are shown to the nearest hundredth of a cubic foot per second for discharges of less than 1 ft^3/s; to the nearest tenths between 1.0 and 10 ft^3/s; to whole numbers between 10 and 1,000 ft^3/s; and to 3 significant figures above 1,000 ft^3/s. The number of significant figures used is based solely on the magnitude of the discharge value. The same rounding rules apply to discharge values listed for partial-record stations.

Discharge at many stations, as indicated by the monthly mean, may not reflect natural runoff due to the effects of diversion, consumption, regulation by storage, increase or decrease in evaporation due to artificial causes, or to other factors. For such stations, values of cubic feet per second per square mile and of runoff in inches are not published unless satisfactory adjustments can be made for diversions, for changes in contents of reservoirs, or for other changes incident to use and control. Evaporation from a reservoir is not included in the adjustments for changes in reservoir contents, unless it is so stated. Even at those stations where adjustments are made, large errors in computed runoff may occur if adjustments or losses are large in comparison with the observed discharge.

Other Data Records Available

Information of a more detailed nature than that published for most of the stream-gaging stations such as discharge measurements, gage-height records, and rating tables is available from the District office. Also, most stream-gaging station records are available in computer-usable form and many statistical analyses have been made.

Information on the availability of unpublished data or statistical analyses may be obtained from the District office (see address that is shown on the back of the title page of this report).

EXPLANATION OF PRECIPITATION RECORDS

Data Collection and Computation

Rainfall data generally are collected using electronic data loggers that measure the rainfall in 0.01-inch increments every 15 minutes using either a tipping-bucket rain gage or a collection well gage. Twenty-four hour rainfall totals are tabulated and presented. A 24-hour period extends from just past midnight of the previous day to midnight of the current day. Snowfall-affected data can result during cold weather when snow fills the rain-gage funnel and then melts as temperatures rise. Snowfall-affected data are subject to errors. Missing values are indicated by this symbol "---" in the table.

Data Presentation

Precipitation records collected at surface-water gaging stations are identified with the same station number and name as the stream-gaging station. Where a surface-water daily-record station is not available, the precipitation record is published with its own name and latitude-longitude identification number.

Information pertinent to the history of a precipitation station is provided in descriptive headings preceding the tabular data. These descriptive headings give details regarding location, period of record, and general remarks.

The following information is provided with each precipitation station. Comments that follow clarify information presented under the various headings of the station description.

LOCATION.—See Data Presentation in the EXPLANATION OF STAGE- AND WATER-DISCHARGE RECORDS section of this report (same comments apply).

PERIOD OF RECORD.—See Data Presentation in the EXPLANATION OF STAGE- AND WATER-DISCHARGE RECORDS section of this report (same comments apply).

INSTRUMENTATION.—Information on the type of rainfall collection system is given.

REMARKS.—Remarks provide added information pertinent to the collection, analysis, or computation of records.

EXPLANATION OF WATER-QUALITY RECORDS

Collection and Examination of Data

Surface-water samples for analysis usually are collected at or near stream-gaging stations. The quality-of-water records are given immediately following the discharge records at these stations.

The descriptive heading for water-quality records gives the period of record for all water-quality data; the period of daily record for parameters that are measured on a daily basis (specific conductance, water temperature, sediment discharge, and so forth); extremes for the current year; and general remarks.

For ground-water records, no descriptive statements are given; however, the well number, depth of well, sampling date, or other pertinent data are given in the table containing the chemical analyses of the ground water.

Water Analysis

Most of the methods used for collecting and analyzing water samples are described in the TWRIs. A list of TWRIs is provided in this report.

One sample can define adequately the water quality at a given time if the mixture of solutes throughout the stream cross-section is homogeneous. However, the concentration of solutes at different locations in the cross section may vary widely with different rates of water discharge, depending on the source of material and the turbulence and mixing of the stream. Some streams must be sampled at several verticals to obtain a representative sample needed for an accurate mean concentration and for use in calculating load.

Chemical-quality data published in this report are considered to be the most representative values available for the stations listed. The values reported represent water-quality conditions at the time of sampling as much as possible, consistent with available sampling techniques and methods of analysis. In the rare case where an apparent inconsistency exists between a reported pH value and the relative abundance of carbon dioxide species (carbonate and bicarbonate), the inconsistency is the result of a slight uptake of carbon dioxide from the air by the sample between measurement of pH in the field and determination of carbonate and bicarbonate in the laboratory.

For chemical-quality stations equipped with digital monitors, the records consist of daily maximum and minimum values (and sometimes mean or median values) for each constituent measured, and are based on 15-minute or 1-hour intervals of recorded data beginning at 0000 hours and ending at 2400 hours for the day of record.

SURFACE-WATER-QUALITY RECORDS

Records of surface-water quality ordinarily are obtained at or near stream-gaging stations because discharge data is useful in the interpretation of surface-water quality. Records of surface-water quality in this report involve a variety of types of data and measurement frequencies.

Classification of Records

Water-quality data for surface-water sites are grouped into one of three classifications. A *continuous-record station* is a site where data are collected on a regularly scheduled basis. Frequency may be one or more times daily, weekly, monthly, or quarterly. A *partial-record station* is a site where limited water-quality data are collected systematically over a period of years. Frequency of sampling is usually less than quarterly. A *miscellaneous sampling site* is a location other than a continuous- or partial-record station, where samples are collected to give better areal coverage to define water-quality conditions in the river basin.

A careful distinction needs to be made between *continuous records* as used in this report and *continuous recordings* that refer to a continuous graph or a series of discrete values recorded at short intervals. Some records of water quality, such as temperature and specific conductance, may be obtained through continuous recordings; however, because of costs, most data are obtained only monthly or less frequently. Locations of stations for which records on the quality of surface water appear in this report are shown in figure 6.

Accuracy of the Records

One of four accuracy classifications is applied for measured physical properties at continuous-record stations on a scale ranging from poor to excellent. The accuracy rating is based on data values recorded before any shifts or corrections are made. Additional consideration also is given to the amount of publishable record and to the amount of data that have been corrected or shifted.

Rating classifications for continuous water-quality records

[≤ less than or equal to; ±, plus or minus value shown; ° C, degree Celsius; >, greater than; %, percent; mg/L, milligram per liter; pH unit, standard pH unit]

Measured physical property	Rating			
	Excellent	Good	Fair	Poor
Water temperature	≤±0.2 ° C	> ±0.2 to 0.5 ° C	> ±0.5 to 0.8 ° C	> ±0.8 ° C
Specific conductance	≤±3%	> ±3 to 10%	> ±10 to 15%	> ±15%
Dissolved oxygen	≤±0.3 mg/L	> ±0.3 to 0.5 mg/L	> ±0.5 to 0.8 mg/L	> ±0.8 mg/L
pH	≤±0.2 unit	> ±0.2 to 0.5 unit	> ±0.5 to 0.8 unit	> ±0.8 unit
Turbidity	≤±5%	> ±5 to 10%	> ±10 to 15%	> ±15%

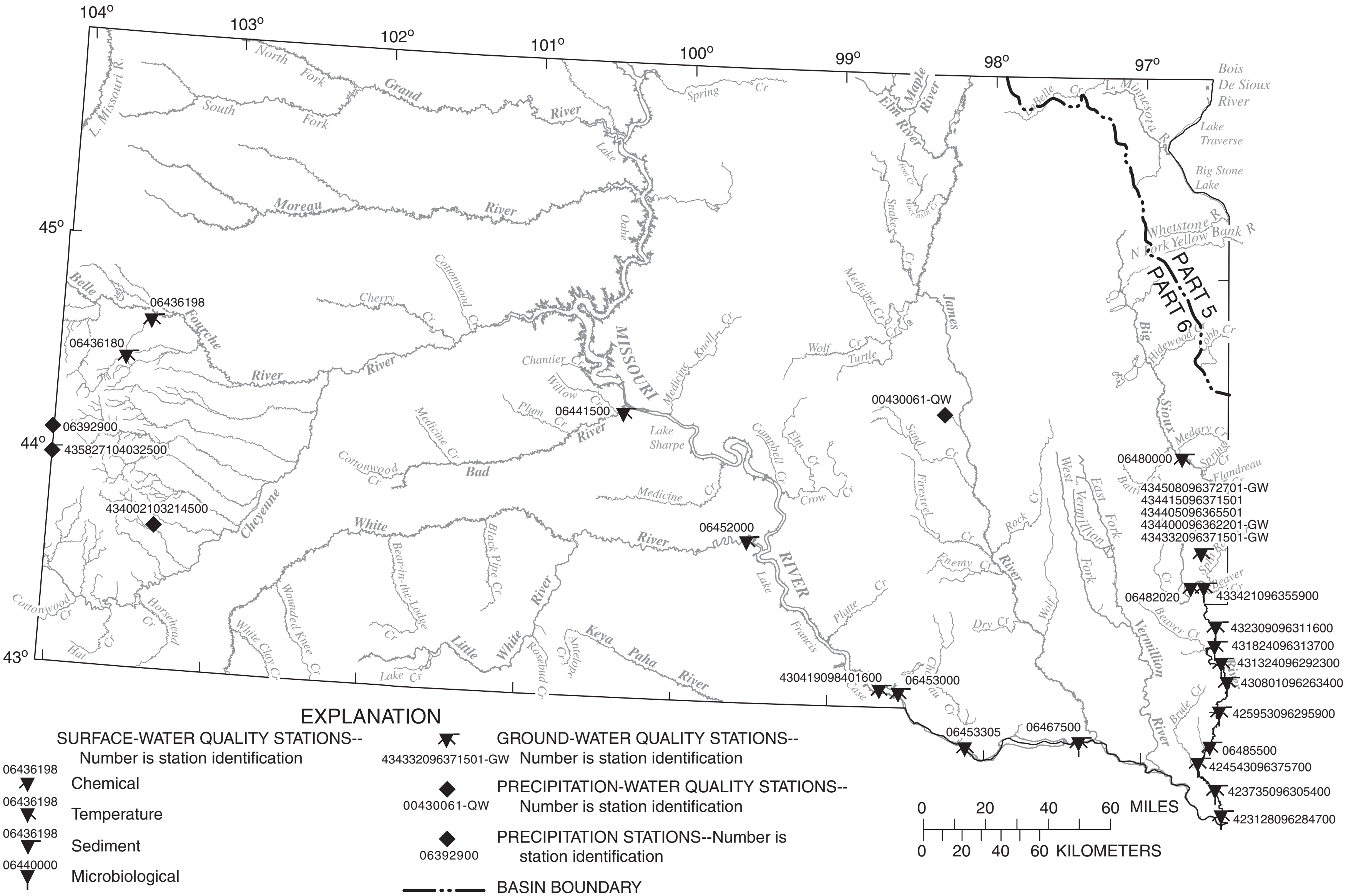


Figure 6. Location of surface-water, ground-water, and precipitation-water quality stations and precipitation stations.

Arrangement of Records

Water-quality records collected at a surface-water daily record station are published immediately following that record, regardless of the frequency of sample collection. Station number and name are the same for both records. Where a surface-water daily record station is not available or where the water quality differs significantly from that at the nearby surface-water station, the continuing water-quality record is published with its own station number and name in the regular downstream-order sequence. Water-quality data for partial-record stations and for miscellaneous sampling sites appear in separate tables following the table of discharge measurements at miscellaneous sites.

On-Site Measurements and Sample Collection

In obtaining water-quality data, a major concern is assuring that the data obtained represent the naturally occurring quality of the water. To ensure this, certain measurements, such as water temperature, pH, and dissolved oxygen, must be made on site when the samples are taken. To assure that measurements made in the laboratory also represent the naturally occurring water, carefully prescribed procedures must be followed in collecting the samples, in treating the samples to prevent changes in quality pending analysis, and in shipping the samples to the laboratory. Procedures for on-site measurements and for collecting, treating, and shipping samples are given in TWRIs Book 1, Chapter D2; Book 3, Chapters A1, A3, and A4; and Book 9, Chapters A1-A9. These TWRIs are listed in this report. Also, detailed information on collecting, treating, and shipping samples can be obtained from the USGS District office (see address that is shown on the back of title page in this report).

Water Temperature

Water temperatures are measured at most of the water-quality stations. In addition, water temperatures are taken at the time of discharge measurements for water-discharge stations. For stations where water temperatures are taken manually once or twice daily, the water temperatures are taken at about the same time each day. Large streams have a small diurnal temperature change; shallow streams may have a daily range of several degrees and may follow closely the changes in air temperature. Some streams may be affected by waste-heat discharges.

At stations where recording instruments are used, either mean temperatures or maximum and minimum temperatures for each day are published. Water temperatures measured at the time of water-discharge measurements are on file in the District office.

Sediment

Suspended-sediment concentrations are determined from samples collected by using depth-integrating samplers. Samples usually are obtained at several verticals in the cross section, or a single sample may be obtained at a fixed point and a coefficient applied to determine the mean concentration in the cross section.

During periods of rapidly changing flow or rapidly changing concentration, samples may be collected more frequently (twice daily or, in some instances, hourly). The published sediment discharges for days of rapidly changing flow or concentration were computed by the subdivided-day method (time-discharge weighted average). Therefore, for those days when the published sediment discharge value differs from the value computed as the product of discharge times mean concentration times 0.0027, the reader can assume that the sediment discharge for that day was computed by the subdivided-day method. For periods when no samples were collected, daily discharges of suspended sediment were estimated on the basis of water discharge, sediment concentrations observed immediately before and after the periods, and suspended-sediment loads for other periods of similar discharge.

At other stations, suspended-sediment samples are collected periodically at many verticals in the stream cross section. Although data collected periodically may represent conditions only at the time of observation, such data are useful in establishing seasonal relations between quality and streamflow and in predicting long-term sediment-discharge characteristics of the stream.

In addition to the records of suspended-sediment discharge, records of the periodic measurements of the particle-size distribution of the suspended sediment and bed material are included for some stations.

Laboratory Measurements

Samples for biochemical oxygen demand (BOD) and indicator bacteria are analyzed locally. All other samples are analyzed in the USGS laboratory in Lakewood, Colorado, unless otherwise noted. Methods used in analyzing sediment samples and computing sediment records are given in TWRI, Book 5, Chapter C1. Methods used by the USGS laboratories are given in the TWRIs, Book 1, Chapter D2; Book 3, Chapter C2; and Book 5, Chapters A1, A3, and A4. These methods are consistent with ASTM standards and generally follow ISO standards.

Data Presentation

For continuing-record stations, information pertinent to the history of station operation is provided in descriptive headings preceding the tabular data. These descriptive headings give details regarding location, drainage area, period of record, type of data available, instrumentation, general remarks, cooperation, and extremes for parameters currently measured daily. Tables of chemical, physical, biological, radiochemical data, and so forth, obtained at a frequency less than daily are presented first. Tables of "daily values" of specific conductance, pH, water temperature, dissolved oxygen, and suspended sediment then follow in sequence.

In the descriptive headings, if the location is identical to that of the discharge gaging station, neither the LOCATION nor the DRAINAGE AREA statements are repeated. The following information is provided with each continuous-record station. Comments that follow clarify information presented under the various headings of the station description.

LOCATION.—See Data Presentation information in the EXPLANATION OF STAGE- AND WATER-DISCHARGE RECORDS section of this report (same comments apply).

DRAINAGE AREA.—See Data Presentation information in the EXPLANATION OF STAGE- AND WATER-DISCHARGE RECORDS section of this report (same comments apply).

PERIOD OF RECORD.—This indicates the time periods for which published water-quality records for the station are available. The periods are shown separately for records of parameters measured daily or continuously and those measured less than daily. For those measured daily or continuously, periods of record are given for the parameters individually.

INSTRUMENTATION.—Information on instrumentation is given only if a water-quality monitor temperature record, sediment pumping sampler, or other sampling device is in operation at a station.

REMARKS.—Remarks provide added information pertinent to the collection, analysis, or computation of the records.

COOPERATION.—Records provided by a cooperating organization or obtained for the USGS by a cooperating organization are identified here.

EXTREMES.—Maximums and minimums are given only for parameters measured daily or more frequently. For parameters measured weekly or less frequently, true maximums or minimums may not have been obtained. Extremes, when given, are provided for both the period of record and for the current water year.

REVISIONS.—Records are revised if errors in published water-quality records are discovered. Appropriate updates are made in the USGS distributed data system, NWIS, and subse-quently to its Web-based National data system, NWISWeb (*http://waterdata.usgs.gov/nwis*). Users of USGS water-quality data are encouraged to obtain all required data from NWIS or NWISWeb to ensure that they have the most recent updates. Updates to the NWISWeb are made on an annual basis.

The surface-water-quality records for partial-record stations and miscellaneous sampling sites are published in separate tables following the tables of precipitation measurements at miscellaneous sites. No descriptive statements are given for these records. Each station is published with its own station number and name in the regular downstream-order sequence.

Remark Codes

The following remark codes may appear with the water-quality data in this section:

Printed Output	Remark
E or e	Estimated value.
>	Actual value is known to be greater than the value shown.
<	Actual value is known to be less than the value shown.
K	Results based on colony count outside the acceptance range (non-ideal colony count).
L	Biological organism count less than 0.5 percent (organism may be observed rather than counted).
D	Biological organism count equal to or greater than 15 percent (dominant).
V	Analyte was detected in both the environmental sample and the associated blanks.
&	Biological organism estimated as dominant.

Water-Quality Control Data

The USGS National Water Quality Laboratory collects quality-control data on a continuing basis to evaluate selected analytical methods to determine long-term method detection levels (LT-MDLs) and laboratory reporting levels (LRLs). These values are re-evaluated each year on the basis of the most recent quality-control data and, consequently, may change from year to year.

This reporting procedure limits the occurrence of false positive error. Falsely reporting a concentration greater than the LT-MDL for a sample in which the analyte is not present is 1 percent or less. Application of the LRL limits the occurrence of false negative error. The chance of falsely reporting a non-detection for a sample in which the analyte is present at a concentration equal to or greater than the LRL is 1 percent or less.

Accordingly, concentrations are reported as less than LRL for samples in which the analyte was either not detected or did not pass identification. Analytes detected at concentrations between the LT-MDL and the LRL and that pass identification criteria are estimated. Estimated concentrations will be noted with a remark code of “E.” These data should be used with the understanding that their uncertainty is greater than that of data reported without the E remark code.

Data generated from quality-control (QC) samples are a requisite for evaluating the quality of the sampling and processing techniques as well as data from the actual samples themselves. Without QC data, environmental sample data cannot be adequately interpreted because the errors associated with the sample data are unknown. The various types of QC samples collected by this District office are described in the following section. Procedures have been established for the storage of water-quality-control data within the USGS. These procedures allow for storage of all derived QC data and are identified so that they can be related to corresponding environmental samples. These data are not presented in this report but are available from the District office.

Blank Samples

Blank samples are collected and analyzed to ensure that environmental samples have not been contaminated in the overall data-collection process. The blank solution used to develop specific types of blank samples is a solution that is free of the analytes of interest. Any measured value signal in a blank sample for an analyte (a specific component measured in a chemical analysis) that was absent in the blank solution is believed to be due to contamination. Many types of blank samples are possible; each is designed to segregate a different part of the overall data-collection process. The types of blank samples collected in this district are:

Field blank—A blank solution that is subjected to all aspects of sample collection, field processing preservation, transportation, and laboratory handling as an environmental sample.

Trip blank—A blank solution that is put in the same type of bottle used for an environmental sample and kept with the set of sample bottles before and after sample collection.

Equipment blank—A blank solution that is processed through all equipment used for collecting and processing an environmental sample (similar to a field blank but normally done in the more controlled conditions of the office).

Sampler blank—A blank solution that is poured or pumped through the same field sampler used for collecting an environmental sample.

Filter blank—A blank solution that is filtered in the same manner and through the same filter apparatus used for an environmental sample.

Splitter blank—A blank solution that is mixed and separated using a field splitter in the same manner and through the same apparatus used for an environmental sample.

Preservation blank—A blank solution that is treated with the sampler preservatives used for an environmental sample.

Reference Samples

Reference material is a solution or material prepared by a laboratory. The reference material composition is certified for one or more properties so that it can be used to assess a measurement method. Samples of reference material are submitted for analysis to ensure that an analytical method is accurate for the known properties of the reference material. Generally, the selected reference material properties are similar to the environmental sample properties.

Replicate Samples

Replicate samples are a set of environmental samples collected in a manner such that the samples are thought to be essentially identical in composition. Replicate is the general case for which a duplicate is the special case consisting of two samples. Replicate samples are collected and analyzed to establish the amount of variability in the data contributed by some part of the collection and analytical process. Many types of replicate samples are possible, each of which may yield slightly different results in a dynamic hydrologic setting, such as a flowing stream. The types of replicate samples collected in this district are:

Concurrent samples—A type of replicate sample in which the samples are collected simultaneously with two or more samplers or by using one sampler and alternating the collection of samples into two or more compositing containers.

Sequential samples—A type of replicate sample in which the samples are collected one after the other, typically over a short time.

Split sample—A type of replicate sample in which a sample is split into subsamples, each subsample contemporaneous in time and space.

Spike Samples

Spike samples are samples to which known quantities of a solution with one or more well-established analyte concentrations have been added. These samples are analyzed to determine the extent of matrix interference or degradation on the analyte concentration during sample processing and analysis.

EXPLANATION OF GROUND-WATER-LEVEL RECORDS

Generally, only ground-water-level data from selected wells with continuous recorders from a basic network of observation wells are published in this report. This basic network contains observation wells located so that the most significant data are obtained from the fewest wells in the most important aquifers.

Site Identification Numbers

Each well is identified by means of a 15-digit number that is based on latitude and longitude. (See NUMBERING SYSTEM FOR WELLS AND MISCELLANEOUS SITES in this report for a detailed explanation.)

Data Collection and Computation

Measurements are made in many types of wells, under varying conditions of access and at different temperatures; hence, neither the method of measurement nor the equipment can be standardized. At each observation well, however, the equipment and techniques used are those that will ensure that measurements at each well are consistent.

Most methods for collecting and analyzing water samples are described in the TWRIs referred to in the On-site Measurements and Sample Collection and the Laboratory Measurements sections in this report. In addition, TWRI Book 1, Chapter D2, describes guidelines for the collection and field analysis of ground-water samples for selected unstable constituents. Procedures for on-site measurements and for collecting, treating, and shipping samples are given in TWRIs Book 1, Chapter D2; Book 3, Chapters A1, A3, and A4; and Book 9, Chapters A1 through A9. The values in this report represent water-quality conditions at the time of sampling, as much as possible, and that are consistent with available sampling techniques and methods of analysis. These methods are consistent with ASTM standards and generally follow ISO standards. Trained personnel collected all samples. The wells sampled were pumped long enough to ensure that the water collected came directly from the aquifer and had not stood for a long time in the well casing where it would have been exposed to the atmosphere and to the material, possibly metal, comprising the casings.

Water-level measurements in this report are given in feet with reference to land-surface datum (lsd). Land-surface datum is a datum plane that is approximately at land surface at each well. If known, the elevation of the land-surface datum above sea level is given in the well description. The height of the measuring point (MP) above or below land-surface datum is given in each well description. Water levels in wells equipped with recording gages are reported daily and on nonrecording wells, water levels are reported on a near 6-week basis.

Water levels are reported to as many significant figures as can be justified by the local conditions. For example, in a measurement of a depth of water of several hundred feet, the error in determining the absolute value of the total depth to water may be a few tenths of a foot, whereas the error in determining the net change of water level between successive measurements may be only a hundredth or a few hundredths of a foot. For lesser depths to water the accuracy is greater. Accordingly, most measurements are reported to a hundredth of a foot, but some are given only to a tenth of a foot or a larger unit.

Data Presentation

Water-level data are presented in alphabetical order by county. The primary identification number for a given well is the 15-digit site identification number that appears in the upper left corner of the table. Well locations are shown in figure 4; each well is identified on the map according to the county.

Each well record consists of three parts: the well description, the data table of water levels observed during the water year, and, for most wells, a hydrograph following the data table. Well descriptions are presented in the headings preceding the tabular data.

The following comments clarify information presented in these various headings.

LOCATION.—This paragraph follows the well-identification number and reports the hydrologic-unit number and a geographic point of reference. Latitudes and longitudes used in this report are reported as North American Datum of 1927 unless otherwise specified.

AQUIFER.—This entry designates by name and geologic age the aquifer that the well taps.

WELL CHARACTERISTICS.—This entry describes the well in terms of depth, casing diameter and depth or screened interval, method of construction, use, and changes since construction.

INSTRUMENTATION.—This paragraph provides information on both the frequency of measurement and the collection method used, allowing the user to better evaluate the reported water-level extremes by knowing whether they are based on continuous, monthly, or some other frequency of measurement.

DATUM.—This entry describes both the measuring point and the land-surface elevation at the well. The altitude of the land-surface datum is described in feet above the altitude datum; it is reported with a precision depending on the method of determination. The measuring point is described physically (such as top of casing, top of instrument shelf, and so forth), and in relation to land surface (such as 1.3 ft above land-surface datum). The elevation of the land-surface datum is described in feet above National Geodetic Vertical Datum of 1929 (NGVD 29); it is reported with a precision depending on the method of determination.

PERIOD OF RECORD.—This entry indicates the time period for which records are published for the well, the month and year at the start of publication of water-level records by the USGS, and the words “to current year” if the records are to be continued into the following year. Time periods for which water-level records are available, but are not published by the USGS, may be noted.

EXTREMES FOR PERIOD OF RECORD.—This entry contains the highest and lowest instantaneously recorded or measured water levels of the period of published record, with respect to land-surface datum or sea level, and the dates of occurrence.

Water-Level Tables

A table of water levels follows the well description for each well. Water-level measurements in this report are given in feet with reference to either sea level or land-surface datum (lsd). Missing records are indicated by dashes in place of the water-level value.

For wells not equipped with recorders, water-level measurements were obtained periodically by steel or electric tape. Tables of periodic water-level measurements in these wells show the date of measurement and the measured water-level value.

Hydrographs

Hydrographs are a graphic display of water-level fluctuations over a period of time. In this report, current water year and, when appropriate, period-of-record hydrographs are shown. Hydrographs that display recorder data show a solid line representing the mean water level recorded for each day. Missing data are indicated by a blank space or break in a hydrograph. Missing data may occur as a result of recorder malfunctions, battery failures, or mechanical problems related to the response of the recorder’s float mechanism to water-level fluctuations in a well.

GROUND-WATER-QUALITY DATA

Data Collection and Computation

The ground-water-quality data in this report were obtained as a part of special studies in specific areas. Consequently, a number of chemical analyses are presented for some wells within a county but not for others. As a result, the records for this year, by themselves, do not provide a balanced view of ground-water quality Statewide.

Most methods for collecting and analyzing water samples are described in the TWRIs. Procedures for on-site measurements and for collecting, treating, and shipping samples are given in TWRI, Book 1, Chapter D2; Book 3, Chapter C2; and Book 5, Chapters A1, A3, and A4. Also, detailed information on collecting, treating, and shipping samples may be obtained from the USGS District office (see address shown on back of title page in this report).

Laboratory Measurements

Analysis for sulfide and measurement of alkalinity, pH, water temperature, specific conductance, and dissolved oxygen are performed on site. All other sample analyses are performed at the USGS laboratory in Lakewood, Colorado, unless otherwise noted. Methods used by the USGS laboratory are given in TWRI, Book 1, Chapter D2; Book 3, Chapter C2; and Book 5, Chapters A1, A3, and A4.

ACCESS TO USGS WATER DATA

The USGS provides near real-time stage and discharge data for many of the gaging stations equipped with the necessary telemetry and historic daily-mean and peak-flow discharge data for most current or discontinued gaging stations through the World Wide Web (WWW). These data may be accessed from *http://water.usgs.gov*.

Water-quality data and ground-water data also are available through the WWW. In addition, data can be provided in various machine-readable formats on various media. Information about the availability of specific types of data or products, and user charges, can be obtained locally from each Water Discipline District Office (see address that is shown on the back of the title page of this report.)

REFERENCE CITED

Fenneman, N.M., 1946, Physical divisions of the United States: Washington, D.C., U.S. Geological Survey special map, scale 1:7,000,000.

DEFINITION OF TERMS

Specialized technical terms related to streamflow, water-quality, and other hydrologic data, as used in this report, are defined below. Terms such as algae, water level, and precipitation are used in their common everyday meanings, definitions of which are given in standard dictionaries. Not all terms defined in this alphabetical list apply to every State. See also table for converting English units to International System (SI) Units. Other glossaries that also define water-related terms are accessible from *http://water.usgs.gov/glossaries.html*.

Acid neutralizing capacity (ANC) is the equivalent sum of all bases or base-producing materials, solutes plus particulates, in an aqueous system that can be titrated with acid to an equivalence point. This term designates titration of an "unfiltered" sample (formerly reported as alkalinity).

Acre-foot (AC-FT, acre-ft) is a unit of volume, commonly used to measure quantities of water used or stored, equivalent to the volume of water required to cover 1 acre to a depth of 1 foot and equivalent to 43,560 cubic feet, 325,851 gallons, or 1,233 cubic meters. (See also "Annual runoff")

Adenosine triphosphate (ATP) is an organic, phosphate-rich compound important in the transfer of energy in organisms. Its central role in living cells makes ATP an excellent indicator of the presence of living material in water. A measurement of ATP therefore provides a sensitive and rapid estimate of biomass. ATP is reported in micrograms per liter.

Adjusted discharge is discharge data that have been mathematically adjusted (for example, to remove the effects of a daily tide cycle or reservoir storage).

Algal growth potential (AGP) is the maximum algal dry weight biomass that can be produced in a natural water sample under standardized laboratory conditions. The growth potential is the algal biomass present at stationary phase and is expressed as milligrams dry weight of algae produced per liter of sample. (See also "Biomass" and "Dry weight")

Alkalinity is the capacity of solutes in an aqueous system to neutralize acid. This term designates titration of a "filtered" sample.

Annual runoff is the total quantity of water that is discharged ("runs off") from a drainage basin in a year. Data reports may present annual runoff data as volumes in acre-feet, as discharges per unit of drainage area in cubic feet per second per square mile, or as depths of water on the drainage basin in inches.

Annual 7-day minimum is the lowest mean value for any 7-consecutive-day period in a year. Annual 7-day minimum values are reported herein for the calendar year and the water year (October 1 through September 30). Most low-flow frequency analyses use a climatic year (April 1-March 31), which tends to prevent the low-flow period from being artificially split between adjacent years. The date shown in the summary statistics table is the initial date of the 7-day period. (This value should not be confused with the 7-day, 10-year low-flow statistic.)

Aroclor is the registered trademark for a group of polychlorinated biphenyls that were manufactured by the Monsanto Company prior to 1976. Aroclors are assigned specific 4-digit reference numbers dependent upon molecular type and degree of substitution of the biphenyl ring hydrogen atoms by chlorine atoms. The first two digits of a numbered aroclor represent the molecular type, and the last two digits represent the percentage weight of the hydrogen-substituted chlorine.

Artificial substrate is a device that purposely is placed in a stream or lake for colonization of organisms. The artificial substrate simplifies the community structure by standardizing the substrate from which each sample is collected. Examples of artificial substrates are basket samplers (made of wire cages filled with clean streamside rocks) and multiplate samplers (made of hardboard) for benthic organism collection, and plexiglass strips for periphyton collection. (See also "Substrate")

Ash mass is the mass or amount of residue present after the residue from a dry-mass determination has been ashed in a muffle furnace at a temperature of 500 °C for 1 hour. Ash mass of zooplankton and phytoplankton is expressed in grams per cubic meter (g/m^3), and periphyton and benthic organisms in grams per square meter (g/m^2). (See also "Biomass" and "Dry mass")

Aspect is the direction toward which a slope faces with respect to the compass.

Bacteria are microscopic unicellular organisms, typically spherical, rodlike, or spiral and threadlike in shape, often clumped into colonies. Some bacteria cause disease, whereas others perform an essential role in nature in the recycling of materials; for example, by decomposing organic matter into a form available for reuse by plants.

Bankfull stage, as used in this report, is the stage at which a stream first overflows its natural banks formed by floods with 1- to 3-year recurrence intervals.

Base discharge (for peak discharge) is a discharge value, determined for selected stations, above which peak discharge data are published. The base discharge at each station is selected so that an average of about three peak flows per year will be published. (See also "Peak flow")

Base flow is sustained flow of a stream in the absence of direct runoff. It includes natural and human-induced streamflows. Natural base flow is sustained largely by ground-water discharge.

Bed material is the sediment mixture of which a stream-bed, lake, pond, reservoir, or estuary bottom is composed. (See also "Bedload" and "Sediment")

Bedload is material in transport that primarily is supported by the streambed. In this report, bedload is considered to consist of particles in transit from the bed to the top of the bedload sampler nozzle (an elevation ranging from 0.25 to 0.5 foot). These particles are retained in the bedload sampler. A sample collected with a pressure-differential bedload sampler also may contain a component of the suspended load.

Bedload discharge (tons per day) is the rate of sediment moving as bedload, reported as dry weight, that passes through a cross section in a given time. NOTE: Bedload discharge values in this report may include a component of the suspended-sediment discharge. A correction may be necessary when computing the total sediment discharge by summing the bedload discharge and the suspended-sediment discharge. (See also "Bedload," "Dry weight," "Sediment," and "Suspended-sediment discharge")

Benthic organisms are the group of organisms inhabiting the bottom of an aquatic environment. They include a number of types of organisms, such as bacteria, fungi, insect larvae and nymphs, snails, clams, and crayfish. They are useful as indicators of water quality.

Biochemical oxygen demand (BOD) is a measure of the quantity of dissolved oxygen, in milligrams per liter, necessary for the decomposition of organic matter by microorganisms, such as bacteria.

Biomass is the amount of living matter present at any given time, expressed as mass per unit area or volume of habitat.

Biomass pigment ratio is an indicator of the total proportion of periphyton that are autotrophic (plants). This also is called the Autotrophic Index.

Blue-green algae (*Cyanophyta*) are a group of phytoplankton and periphyton organisms with a blue pigment in addition to a green pigment called chlorophyll. Blue-green algae can cause nuisance water-quality conditions in lakes and slow-flowing rivers; however, they are found commonly in streams throughout the year. The abundance of blue-green algae in phytoplankton samples is expressed as the number of cells per milliliter (cells/mL) or biovolume in cubic micrometers per milliliter (μm^3/mL). The abundance of blue-green algae in periphyton samples is given in cells per square centimeter (cells/cm^2) or biovolume per square centimeter ($\mu m^3/cm^2$). (See also “Phytoplankton”and “Periphyton”)

Bottom material (See “Bed material”)

Bulk electrical conductivity is the combined electrical conductivity of all material within a doughnut-shaped volume surrounding an induction probe. Bulk conductivity is affected by different physical and chemical properties of the material including the dissolved-solids content of the pore water, and the lithology and porosity of the rock.

Canadian Geodetic Vertical Datum 1928 is a geodetic datum derived from a general adjustment of Canada’s first order level network in 1928.

Cell volume (biovolume) determination is one of several common methods used to estimate biomass of algae in aquatic systems. Cell members of algae are used frequently in aquatic surveys as an indicator of algal production. However, cell numbers alone cannot represent true biomass because of considerable cell-size variation among the algal species. Cell volume (μm^3) is determined by obtaining critical cell measurements or cell dimensions (for example, length, width, height, or radius) for 20 to 50 cells of each important species to obtain an average biovolume per cell. Cells are categorized according to the correspondence of their cellular shape to the nearest geometric solid or combinations of simple solids (for example, spheres, cones, or cylinders). Representative formulae used to compute biovolume are as follows:

sphere $4/3\ \pi r^3$ cone $1/3\ \pi r^2 h$ cylinder $\pi r^2 h$.

pi (π) is the ratio of the circumference to the diameter of a circle; pi = 3.14159….

From cell volume, total algal biomass expressed as biovolume (μm^3/mL) is thus determined by multiplying the number of cells of a given species by its average cell volume and then summing these volumes for all species.

Cells/volume refers to the number of cells of any organism that is counted by using a microscope and grid or counting cell. Many planktonic organisms are multicelled and are counted according to the number of contained cells per sample volume, and generally are reported as cells or units per milliliter (mL) or liter (L).

Cfs-day (See “Cubic foot per second-day”)

Channel bars, as used in this report, are the lowest prominent geomorphic features higher than the channel bed.

Chemical oxygen demand (COD) is a measure of the chemically oxidizable material in the water and furnishes an approximation of the amount of organic and reducing material present. The determined value may correlate with BOD or with carbonaceous organic pollution from sewage or industrial wastes. [See also “Biochemical oxygen demand (BOD)”]

***Clostridium perfringens** (C. perfringens)* is a spore-forming bacterium that is common in the feces of human and other warmblooded animals. Clostridial spores are being used experimentally as an indicator of past fecal contamination and the presence of microorganisms that are resistant to disinfection and environmental stresses. (See also “Bacteria”)

Coliphages are viruses that infect and replicate in coliform bacteria. They are indicative of sewage contamination of water and of the survival and transport of viruses in the environment.

Color unit is produced by 1 milligram per liter of platinum in the form of the chloroplatinate ion. Color is expressed in units of the platinum-cobalt scale.

Confined aquifer is a term used to describe an aquifer containing water between two relatively impermeable bound-aries. The water level in a well tapping a confined aquifer stands above the top of the confined aquifer and can be higher or lower than the water table that may be present in the material above it. In some cases, the water level can rise above the ground surface, yielding a flowing well.

Contents is the volume of water in a reservoir or lake. Unless otherwise indicated, volume is computed on the basis of a level pool and does not include bank storage.

Continuous-record station is a site where data are collected with sufficient frequency to define daily mean values and variations within a day.

Control designates a feature in the channel that physically affects the water-surface elevation and thereby determines the stage-discharge relation at the gage. This feature may be a constriction of the channel, a bedrock outcrop, a gravel bar, an artificial structure, or a uniform cross section over a long reach of the channel.

Control structure, as used in this report, is a structure on a stream or canal that is used to regulate the flow or stage of the stream or to prevent the intrusion of saltwater.

Cubic foot per second (CFS, ft^3/s) is the rate of discharge representing a volume of 1 cubic foot passing a given point in 1 second. It is equivalent to approximately 7.48 gallons per second or approximately 449 gallons per minute, or 0.02832 cubic meters per second. The term “second-foot” sometimes is used synonymously with “cubic foot per second” but is now obsolete.

Cubic foot per second-day (CFS-DAY, Cfs-day, [$(ft^3/s)/d$]) is the volume of water represented by a flow of 1 cubic foot per second for 24 hours. It is equivalent to 86,400 cubic feet, 1.98347 acre-feet, 646,317 gallons, or 2,446.6 cubic meters. The daily mean discharges reported in the daily value data tables numerically are equal to the daily volumes in cfs-days, and the totals also represent volumes in cfs-days.

Cubic foot per second per square mile [CFSM, $(ft^3/s)/mi^2$] is the average number of cubic feet of water flowing per second from each square mile of area drained, assuming the runoff is distributed uniformly in time and area. (See also “Annual runoff”)

Daily mean suspended-sediment concentration is the time-weighted mean concentration of suspended sediment passing a stream cross section during a 24-hour day. (See also “Sediment” and “Suspended-sediment concentration”)

Daily record station is a site where data are collected with sufficient frequency to develop a record of one or more data values per day. The frequency of data collection can range from continuous recording to data collection on a daily or near-daily basis.

Data collection platform (DCP) is an electronic instrument that collects, processes, and stores data from various sensors, and transmits the data by satellite data relay, line-of-sight radio, and/or landline telemetry.

Data logger is a microprocessor-based data acquisition system designed specifically to acquire, process, and store data. Data usually are downloaded from onsite data loggers for entry into office data systems.

Datum is a surface or point relative to which measurements of height and/or horizontal position are reported. A vertical datum is a horizontal surface used as the zero point for measurements of gage height, stage, or elevation; a horizontal datum is a reference for positions given in terms of latitude-longitude, State Plane coordinates, or Universal Transverse Mercator (UTM) coordinates. (See also “Gage datum,” “Land-surface datum,” “National Geodetic Vertical Datum of 1929,” and “North American Vertical Datum of 1988”)

Diatoms *(Bacillariophyta)* are unicellular or colonial algae with a siliceous cell wall. The abundance of diatoms in phytoplankton samples is expressed as the number of cells per milliliter (cells/mL) or biovolume in cubic micrometers per milliliter (μm^3/mL). The abundance of diatoms in periphyton samples is given in cells per square centimeter (cells/cm^2) or biovolume per square centimeter ($\mu m^3/cm^2$). (See also “Phytoplankton” and “Periphyton”)

Diel is of or pertaining to a 24-hour period of time; a regular daily cycle.

Discharge, or **flow**, is the rate that matter passes through a cross section of a stream channel or other water body per unit of time. The term commonly refers to the volume of water (including, unless otherwise stated, any sediment or other constituents suspended or dissolved in the water) that passes a cross section in a stream channel, canal, pipeline, and so forth, within a given period of time (cubic feet per second). Discharge also can apply to the rate at which constituents, such as suspended sediment, bedload, and dissolved or suspended chemicals, pass through a cross section, in which cases the quantity is expressed as the mass of constituent that passes the cross section in a given period of time (tons per day).

Dissolved refers to that material in a representative water sample that passes through a 0.45-micrometer membrane filter. This is a convenient operational definition used by Federal and State agencies that collect water-quality data. Determinations of “dissolved” constituent concentrations are made on sample water that has been filtered.

Dissolved oxygen (DO) is the molecular oxygen (oxygen gas) dissolved in water. The concentration in water is a function of atmospheric pressure, temperature, and dissolved-solids concentration of the water. The ability of water to retain oxygen decreases with increasing temperature or dissolved-solids concentration. Photosynthesis and respiration by plants commonly cause diurnal variations in dissolved-oxygen concentration in water from some streams.

Dissolved solids concentration in water is the quantity of dissolved material in a sample of water. It is determined either analytically by the “residue-on-evaporation” method, or mathematically by totaling the concentrations of individual constituents reported in a comprehensive chemical analysis. During the analytical determination, the bicarbonate (generally a major dissolved component of water) is converted to carbonate. In the mathematical calculation, the bicarbonate value, in milligrams per liter, is multiplied by 0.4926 to convert it to carbonate. Alternatively, alkalinity concentration (as mg/L $CaCO_3$) can be converted to carbonate concentration by multiplying by 0.60.

Diversity index (H) (Shannon index) is a numerical expression of evenness of distribution of aquatic organisms. The formula for diversity index is:

$$\bar{d} = -\sum_{i \approx 1}^{s} \frac{n_i}{n}\log_2\frac{n_i}{n},$$

where n_i is the number of individuals per taxon, n is the total number of individuals, and s is the total number of taxa in the sample of the community. Index values range from zero, when all the organisms in the sample are the same, to some positive number, when some or all of the organisms in the sample are different.

Drainage area of a stream at a specific location is that area upstream from the location, measured in a horizontal plane, that has a common outlet at the site for its surface runoff from precipitation that normally drains by gravity into a stream. Drainage areas given herein include all closed basins, or noncontributing areas, within the area unless otherwise specified.

Drainage basin is a part of the Earth’s surface that contains a drainage system with a common outlet for its surface runoff. (See “Drainage area”)

Dry mass refers to the mass of residue present after drying in an oven at 105 °C, until the mass remains unchanged. This mass represents the total organic matter, ash and sediment, in the sample. Dry-mass values are expressed in the same units as ash mass. (See also “Ash mass,” “Biomass,” and “Wet mass”)

Dry weight refers to the weight of animal tissue after it has been dried in an oven at 65 °C until a constant weight is achieved. Dry weight represents total organic and inorganic matter in the tissue. (See also “Wet weight”)

Embeddedness is the degree to which gravel-sized and larger particles are surrounded or enclosed by finer-sized particles. (See also “Substrate embeddedness class”)

Enterococcus bacteria commonly are found in the feces of humans and other warmblooded animals. Although some strains are ubiquitous and not related to fecal pollution, the presence of enterococci in water is an indication of fecal pollution and the possible presence of enteric pathogens. Enterococcus bacteria are those bacteria that produce pink to red colonies with black or reddish-brown precipitate after incubation at 41 °C on mE agar (nutrient medium for bacterial growth) and subsequent transfer to EIA medium. Enterococci include *Streptococcus feacalis, Streptococcus feacium, Streptococcus avium,* and their variants. (See also “Bacteria”)

EPT Index is the total number of distinct taxa within the insect orders Ephemeroptera, Plecoptera, and Trichoptera. This index summarizes the taxa richness within the aquatic insects that generally are considered pollution sensitive; the index usually decreases with pollution.

Escherichia coli *(E. coli)* are bacteria present in the intestine and feces of warmblooded animals. *E. coli* are a member species of the fecal coliform group of indicator bacteria. In the laboratory, they are defined as those bacteria that produce yellow or yellow-brown colonies on a filter pad saturated with urea substrate broth after primary culturing for 22 to 24 hours at 44.5 °C on mTEC medium (nutrient medium for bacterial growth). Their concentrations are expressed as number of colonies per 100 mL of sample. (See also “Bacteria”)

Estimated (E) value of a concentration is reported when an analyte is detected and all criteria for a positive result are met. If the concentration is less than the method detection limit (MDL), an E code will be reported with the value. If the analyte is identified qualitatively as present, but the quantitative determination is substantially more uncertain, the National Water Quality Laboratory will identify the result with an E code even though the measured value is greater than the MDL. A value reported with an E code should be used with caution. When no analyte is detected in a sample, the default reporting value is the MDL preceded by a less than sign (<). For bacteriological data, concentrations are reported as estimated when results are based on non-ideal colony counts.

Euglenoids (*Euglenophyta*) are a group of algae that usually are free-swimming and rarely creeping. They have the ability to grow either photosynthetically in the light or heterotrophically in the dark. (See also “Phytoplankton”)

Extractable organic halides (EOX) are organic compounds that contain halogen atoms such as chlorine. These organic compounds are semivolatile and extractable by ethyl acetate from air-dried streambed sediment. The ethyl acetate extract is combusted, and the concentration is determined by microcoulometric determination of the halides formed. The concentration is reported as micrograms of chlorine per gram of the dry weight of the streambed sediment.

Fecal coliform bacteria are present in the intestines or feces of warmblooded animals. They often are used as indicators of the sanitary quality of the water. In the laboratory, they are defined as all organisms that produce blue colonies within 24 hours when incubated at 44.5 °C plus or minus 0.2 °C on M-FC medium (nutrient medium for bacterial growth). Their concentrations are expressed as number of colonies per 100 mL of sample. (See also “Bacteria”)

Fecal streptococcal bacteria are present in the intestines of warmblooded animals and are ubiquitous in the environment. They are characterized as gram-positive, cocci bacteria that are capable of growth in brain-heart infusion broth. In the laboratory, they are defined as all the organisms that produce red or pink colonies within 48 hours at 35 °C plus or minus 1.0 °C on KF-streptococcus medium (nutrient medium for bacterial growth). Their concentrations are expressed as number of colonies per 100 mL of sample. (See also “Bacteria”)

Fire algae (*Pyrrhophyta*) are free-swimming unicells characterized by a red pigment spot. (See also “Phytoplankton”)

Flow-duration percentiles are values on a scale of 100 that indicate the percentage of time for which a flow is not exceeded. For example, the 90th percentile of river flow is greater than or equal to 90 percent of all recorded flow rates.

Gage datum is a horizontal surface used as a zero point for measurement of stage or gage height. This surface usually is located slightly below the lowest point of the stream bottom such that the gage height is usually slightly greater than the maximum depth of water. Because the gage datum is not an actual physical object, the datum is usually defined by specifying the elevations of permanent reference marks such as bridge abutments and survey monuments, and the gage is set to agree with the reference marks. Gage datum is a local datum that is maintained independently of any national geodetic datum. However, if the elevation of the gage datum relative to the national datum (North American Vertical Datum of 1988 or National Geodetic Vertical Datum of 1929) has been determined, then the gage readings can be converted to elevations above the national datum by adding the elevation of the gage datum to the gage reading.

Gage height (G.H.) is the water-surface elevation, in feet above the gage datum. If the water surface is below the gage datum, the gage height is negative. Gage height often is used interchangeably with the more general term “stage,” although gage height is more appropriate when used in reference to a reading on a gage.

Gage values are values that are recorded, transmitted, and/or computed from a gaging station. Gage values typically are collected at 5-, 15-, or 30-minute intervals.

Gaging station is a site on a stream, canal, lake, or reservoir where systematic observations of stage, discharge, or other hydrologic data are obtained.

Gas chromatography/flame ionization detector (GC/FID) is a laboratory analytical method used as a screening technique for semivolatile organic compounds that are extractable from water in methylene chloride.

Geomorphic channel units, as used in this report, are fluvial geomorphic descriptors of channel shape and stream velocity. Pools, riffles, and runs are types of geomorphic channel units considered for National Water-Quality Assessment (NAWQA) Program habitat sampling.

Green algae *(Chlorophyta)* are unicellular or colonial algae with chlorophyll pigments similar to those in terrestrial green plants. Some forms of green algae produce mats or floating “moss” in lakes. The abundance of green algae in phytoplankton samples is expressed as the number of cells per milliliter (cells/mL) or biovolume in cubic micrometers per milliliter (μm^3/mL). The abundance of green algae in periphyton samples is given in cells per square centimeter (cells/cm^2) or biovolume per square centimeter (μm^3/cm^2). (See also “Phytoplankton” and “Periphyton”)

Habitat, as used in this report, includes all nonliving (physical) aspects of the aquatic ecosystem, although living components like aquatic macrophytes and riparian vegetation also are usually included. Measurements of habitat typically are made over a wider geographic scale than are measurements of species distribution.

Habitat quality index is the qualitative description (level 1) of instream habitat and riparian conditions surrounding the reach sampled. Scores range from 0 to 100 percent with higher scores indicative of desirable habitat conditions for aquatic life. Index only applicable to wadable streams.

Hardness of water is a physical-chemical characteristic that commonly is recognized by the increased quantity of soap required to produce lather. It is computed as the sum of equivalents of polyvalent cations (primarily calcium and magnesium) and is expressed as the equivalent concentration of calcium carbonate ($CaCO_3$).

High tide is the maximum height reached by each rising tide. The high-high and low-high tides are the higher and lower of the two high tides, respectively, of each tidal day. *See NOAA Web site: http://www.co-ops.nos.noaa.gov/tideglos.html*

Hilsenhoff's Biotic Index (HBI) is an indicator of organic pollution that uses tolerance values to weight taxa abundances; usually increases with pollution. It is calculated as follows:

$$HBI = sum\frac{(n)(a)}{N},$$

where *n* is the number of individuals of each taxon, *a* is the tolerance value of each taxon, and *N* is the total number of organisms in the sample.

Horizontal datum (See "Datum")

Hydrologic index stations referred to in this report are continuous-record gaging stations that have been selected as representative of streamflow patterns for their respective regions. Station locations are shown on index maps.

Hydrologic unit is a geographic area representing part or all of a surface drainage basin or distinct hydrologic feature as defined by the former Office of Water Data Coordination and delineated on the State Hydrologic Unit Maps by the USGS. Each hydrologic unit is identified by an 8-digit number.

Inch (IN., in.), in reference to streamflow, as used in this report, refers to the depth to which the drainage area would be covered with water if all of the runoff for a given time period were distributed uniformly on it. (See also "Annual runoff")

Instantaneous discharge is the discharge at a particular instant of time. (See also "Discharge")

International Boundary Commission Survey Datum refers to a geodetic datum established at numerous monuments along the United States-Canada boundary by the International Boundary Commission.

Island, as used in this report, is a mid-channel bar that has permanent woody vegetation, is flooded once a year, on average, and remains stable except during large flood events.

Laboratory reporting level (LRL) generally is equal to twice the yearly determined long-term method detection level (LT-MDL). The LRL controls false negative error. The probability of falsely reporting a nondetection for a sample that contained an analyte at a concentration equal to or greater than the LRL is predicted to be less than or equal to 1 percent. The value of the LRL will be reported with a "less than" (<) remark code for samples in which the analyte was not detected. The National Water Quality Laboratory (NWQL) collects quality-control data from selected analytical methods on a continuing basis to determine LT-MDLs and to establish LRLs. These values are reevaluated annually on the basis of the most current quality-control data and, therefore, may change. The LRL replaces the term 'non-detection value' (NDV).

Land-surface datum (lsd) is a datum plane that is approximately at land surface at each ground-water observation well.

Latent heat flux (often used interchangeably with latent heat-flux density) is the amount of heat energy that converts water from liquid to vapor (evaporation) or from vapor to liquid (condensation) across a specified cross-sectional area per unit time. Usually expressed in watts per square meter.

Light-attenuation coefficient, also known as the extinction coefficient, is a measure of water clarity. Light is attenuated according to the Lambert-Beer equation:

$$I = I_o e^{-\lambda L},$$

where I_o is the source light intensity, *I* is the light intensity at length *L* (in meters) from the source, λ is the light-attenuation coefficient, and *e* is the base of the natural logarithm. The light-attenuation coefficient is defined as

$$\lambda = -\frac{1}{L}\log_e\frac{I}{I_o}.$$

Lipid is any one of a family of compounds that are insoluble in water and that make up one of the principal components of living cells. Lipids include fats, oils, waxes, and steroids. Many environmental contaminants such as organochlorine pesticides are lipophilic.

Long-term method detection level (LT-MDL) is a detection level derived by determining the standard deviation of a minimum of 24 method detection limit (MDL) spike-sample measurements over an extended period of time. LT-MDL data are collected on a continuous basis to assess year-to-year variations in the LT-MDL. The LT-MDL controls false positive error. The chance of falsely reporting a concentration at or greater than the LT-MDL for a sample that did not contain the analyte is predicted to be less than or equal to 1 percent.

Low tide is the minimum height reached by each falling tide. The high-low and low-low tides are the higher and lower of the two low tides, respectively, of each tidal day. *See NOAA Web site: http://www.co-ops.nos.noaa.gov/tideglos.html*

Macrophytes are the macroscopic plants in the aquatic environment. The most common macrophytes are the rooted vascular plants that usually are arranged in zones in aquatic ecosystems and restricted in the area by the extent of illumination through the water and sediment deposition along the shoreline.

Mean concentration of suspended sediment (Daily mean suspended-sediment concentration) is the time-weighted concentration of suspended sediment passing a stream cross section during a given time period. (See also “Daily mean suspended-sediment concentration” and “Suspended-sediment concentration”)

Mean discharge (MEAN) is the arithmetic mean of individual daily mean discharges during a specific period. (See also “Discharge”)

Mean high or **low tide** is the average of all high or low tides, respectively, over a specific period.

Mean sea level is a local tidal datum. It is the arithmetic mean of hourly heights observed over the National Tidal Datum Epoch. Shorter series are specified in the name; for example, monthly mean sea level and yearly mean sea level. In order that they may be recovered when needed, such datums are referenced to fixed points known as benchmarks. (See also “Datum”)

Measuring point (MP) is an arbitrary permanent reference point from which the distance to water surface in a well is measured to obtain water level.

Megahertz is a unit of frequency. One megahertz equals one million cycles per second.

Membrane filter is a thin microporous material of specific pore size used to filter bacteria, algae, and other very small particles from water.

Metamorphic stage refers to the stage of development that an organism exhibits during its transformation from an immature form to an adult form. This developmental process exists for most insects, and the degree of difference from the immature stage to the adult form varies from relatively slight to pronounced, with many intermediates. Examples of metamorphic stages of insects are egg-larva-adult or egg-nymph-adult.

Method detection limit (MDL) is the minimum concentration of a substance that can be measured and reported with 99-percent confidence that the analyte concentration is greater than zero. It is determined from the analysis of a sample in a given matrix containing the analyte. At the MDL concentration, the risk of a false positive is predicted to be less than or equal to 1 percent.

Method of Cubatures is a method of computing discharge in tidal estuaries based on the conservation of mass equation.

Methylene blue active substances (MBAS) indicate the presence of detergents (anionic surfactants). The determination depends on the formation of a blue color when methylene blue dye reacts with synthetic anionic detergent compounds.

Micrograms per gram (UG/G, µg/g) is a unit expressing the concentration of a chemical constituent as the mass (micrograms) of the element per unit mass (gram) of material analyzed.

Micrograms per kilogram (UG/KG, µg/kg) is a unit expressing the concentration of a chemical constituent as the mass (micrograms) of the constituent per unit mass (kilogram) of the material analyzed. One microgram per kilogram is equivalent to 1 part per billion.

Micrograms per liter (UG/L, µg/L) is a unit expressing the concentration of chemical constituents in water as mass (micrograms) of constituent per unit volume (liter) of water. One thousand micrograms per liter is equivalent to 1 milligram per liter. One microgram per liter is equivalent to 1 part per billion.

Microsiemens per centimeter (US/CM, µS/cm) is a unit expressing the amount of electrical conductivity of a solution as measured between opposite faces of a centimeter cube of solution at a specified temperature. Siemens is the International System of Units nomenclature. It is synonymous with mhos and is the reciprocal of resistance in ohms.

Milligrams per liter (MG/L, mg/L) is a unit for expressing the concentration of chemical constituents in water as the mass (milligrams) of constituent per unit volume (liter) of water. Concentration of suspended sediment also is expressed in milligrams per liter and is based on the mass of dry sediment per liter of water-sediment mixture.

Minimum reporting level (MRL) is the smallest measured concentration of a constituent that may be reliably reported by using a given analytical method.

Miscellaneous site, miscellaneous station, or miscellaneous sampling site is a site where streamflow, sediment, and/or water-quality data or water-quality or sediment samples are collected once, or more often on a random or discontinuous basis to provide better areal coverage for defining hydrologic and water-quality conditions over a broad area in a river basin.

Most probable number (MPN) is an index of the number of coliform bacteria that, more probably than any other number, would give the results shown by the laboratory examination; it is not an actual enumeration. MPN is determined from the distribution of gas-positive cultures among multiple inoculated tubes.

Multiple-plate samplers are artificial substrates of known surface area used for obtaining benthic invertebrate samples. They consist of a series of spaced, hardboard plates on an eyebolt.

Nanograms per liter (NG/L, ng/L) is a unit expressing the concentration of chemical constituents in solution as mass (nanograms) of solute per unit volume (liter) of water. One million nanograms per liter is equivalent to 1 milligram per liter.

National Geodetic Vertical Datum of 1929 (NGVD 29) is a fixed reference adopted as a standard geodetic datum for elevations determined by leveling. It formerly was called “Sea Level Datum of 1929” or “mean sea level.” Although the datum was derived from the mean sea level at 26 tide stations**,** it does not necessarily represent local mean sea level at any particular place. *See NOAA Web site: http://www.ngs.noaa.gov/faq.shtml#WhatVD29VD88* (See “North American Vertical Datum of 1988”)

Natural substrate refers to any naturally occurring immersed or submersed solid surface, such as a rock or tree, upon which an organism lives. (See also “Substrate”)

Nekton are the consumers in the aquatic environment and consist of large, free-swimming organisms that are capable of sustained, directed mobility.

Nephelometric turbidity unit (NTU) is the measurement for reporting turbidity that is based on use of a standard suspension of formazin. Turbidity measured in NTU uses nephelometric methods that depend on passing specific light of a specific wavelength through the sample.

North American Datum of 1927 (NAD 27) is the horizontal control datum for the United States that was defined by a location and azimuth on the Clarke spheroid of 1866.

North American Datum of 1983 (NAD 83) is the horizontal control datum for the United States, Canada, Mexico, and Central America that is based on the adjustment of 250,000 points including 600 satellite Doppler stations that constrain the system to a geocentric origin. NAD 83 has been officially adopted as the legal horizontal datum for the United States by the Federal government.

North American Vertical Datum of 1988 (NAVD 88) is a fixed reference adopted as the official civilian vertical datum for elevations determined by Federal surveying and mapping activities in the United States. This datum was established in 1991 by minimum-constraint adjustment of the Canadian**,** Mexican, and United States first-order terrestrial leveling networks.

Open or **screened interval** is the length of unscreened opening or of well screen through which water enters a well, in feet below land surface.

Organic carbon (OC) is a measure of organic matter present in aqueous solution, suspension, or bottom sediment. May be reported as dissolved organic carbon (DOC), particulate organic carbon (POC), or total organic carbon (TOC).

Organic mass or **volatile mass** of a living substance is the difference between the dry mass and ash mass and represents the actual mass of the living matter. Organic mass is expressed in the same units as for ash mass and dry mass. (See also “Ash mass,” “Biomass,” and “Dry mass”)

Organism count/area refers to the number of organisms collected and enumerated in a sample and adjusted to the number per area habitat, usually square meter (m^2), acre, or hectare. Periphyton, benthic organisms, and macrophytes are expressed in these terms.

Organism count/volume refers to the number of organisms collected and enumerated in a sample and adjusted to the number per sample volume, usually milliliter (mL) or liter (L). Numbers of planktonic organisms can be expressed in these terms.

Organochlorine compounds are any chemicals that contain carbon and chlorine. Organochlorine compounds that are important in investigations of water, sediment, and biological quality include certain pesticides and industrial compounds.

Parameter code is a 5-digit number used in the USGS computerized data system, National Water Information System (NWIS), to uniquely identify a specific constituent or property.

Partial-record station is a site where discrete measurements of one or more hydrologic parameters are obtained over a period of time without continuous data being recorded or computed. A common example is a crest-stage gage partial-record station at which only peak stages and flows are recorded.

Particle size is the diameter, in millimeters (mm), of a particle determined by sieve or sedimentation methods. The sedimentation method uses the principle of Stokes Law to calculate sediment particle sizes. Sedimentation methods (pipet, bottom-withdrawal tube, visual-accumulation tube, sedigraph) determine fall diameter of particles in either distilled water (chemically dispersed) or in native water (the river water at the time and point of sampling).

Particle-size classification, as used in this report, agrees with the recommendation made by the American Geophysical Union Subcommittee on Sediment Terminology. The classification is as follows:

Classification	Size (mm)	Method of analysis
Clay	>0.00024 - 0.004	Sedimentation
Silt	>0.004 - 0.062	Sedimentation
Sand	>0.062 - 2.0	Sedimentation/sieve
Gravel	>2.0 - 64.0	Sieve
Cobble	>64 - 256	Manual measurement
Boulder	>256	Manual measurement

The particle-size distributions given in this report are not necessarily representative of all particles in transport in the stream. For the sedimentation method, most of the organic matter is removed, and the sample is subjected to mechanical and chemical dispersion before analysis in distilled water. Chemical dispersion is not used for native water analysis.

Peak flow (peak stage) is an instantaneous local maximum value in the continuous time series of streamflows or stages, preceded by a period of increasing values and followed by a period of decreasing values. Several peak values ordinarily occur in a year. The maximum peak value in a year is called the annual peak; peaks lower than the annual peak are called secondary peaks. Occasionally, the annual peak may not be the maximum value for the year; in such cases, the maximum value occurs at midnight at the beginning or end of the year, on the recession from or rise toward a higher peak in the adjoining year. If values are recorded at a discrete series of times, the peak recorded value may be taken as an approximation of the true peak, which may occur between the recording instants. If the values are recorded with finite precision, a sequence of equal recorded values may occur at the peak; in this case, the first value is taken as the peak.

Percent composition or **percent of total** is a unit for expressing the ratio of a particular part of a sample or population to the total sample or population, in terms of types, numbers, weight, mass, or volume.

Percent shading is a measure of the amount of sunlight potentially reaching the stream. A clinometer is used to measure left and right bank canopy angles. These values are added together, divided by 180, and multiplied by 100 to compute percentage of shade.

Periodic-record station is a site where stage, discharge, sediment, chemical, physical, or other hydrologic measurements are made one or more times during a year but at a frequency insufficient to develop a daily record.

Periphyton is the assemblage of microorganisms attached to and living upon submerged solid surfaces. Although primarily consisting of algae, they also include bacteria, fungi, protozoa, rotifers, and other small organisms. Periphyton are useful indicators of water quality.

Pesticides are chemical compounds used to control undesirable organisms. Major categories of pesticides include insecticides, miticides, fungicides, herbicides, and rodenticides.

pH of water is the negative logarithm of the hydrogen-ion activity. Solutions with pH less than 7.0 standard units are termed “acidic,” and solutions with a pH greater than 7.0 are termed “basic.” Solutions with a pH of 7.0 are neutral. The presence and concentration of many dissolved chemical constituents found in water are affected, in part, by the hydrogen-ion activity of water. Biological processes including growth, distribution of organisms, and toxicity of the water to organisms also are affected, in part, by the hydrogen-ion activity of water.

Phytoplankton is the plant part of the plankton. They usually are microscopic, and their movement is subject to the water currents. Phytoplankton growth is dependent upon solar radiation and nutrient substances. Because they are able to incorporate as well as release materials to the surrounding water, the phytoplankton have a profound effect upon the quality of the water. They are the primary food producers in the aquatic environment and commonly are known as algae. (See also “Plankton”)

Picocurie (PC, pCi) is one-trillionth (1×10^{-12}) of the amount of radioactive nuclide represented by a curie (Ci). A curie is the quantity of radioactive nuclide that yields 3.7×10^{10} radioactive disintegrations per second (dps). A picocurie yields 0.037 dps, or 2.22 dpm (disintegrations per minute).

Plankton is the community of suspended, floating, or weakly swimming organisms that live in the open water of lakes and rivers. Concentrations are expressed as a number of cells per milliliter (cells/mL) of sample.

Polychlorinated biphenyls (PCBs) are industrial chemicals that are mixtures of chlorinated biphenyl compounds having various percentages of chlorine. They are similar in structure to organochlorine insecticides.

Polychlorinated naphthalenes (PCNs) are industrial chemicals that are mixtures of chlorinated naphthalene compounds. They have properties and applications similar to polychlorinated biphenyls (PCBs) and have been identified in commercial PCB preparations.

Pool, as used in this report, is a small part of a stream reach with little velocity, commonly with water deeper than surrounding areas.

Primary productivity is a measure of the rate at which new organic matter is formed and accumulated through photo-synthetic and chemosynthetic activity of producer organisms (chiefly, green plants). The rate of primary production is estimated by measuring the amount of oxygen released (oxygen method) or the amount of carbon assimilated (carbon method) by the plants.

Primary productivity (carbon method) is expressed as milligrams of carbon per area per unit time [mg C/(m^2/time)] for periphyton and macrophytes or per volume [mg C/(m^3/time)] for phytoplankton. The carbon method defines the amount of carbon dioxide consumed as measured by radioactive carbon (carbon-14). The carbon-14 method is of greater sensitivity than the oxygen light- and dark-bottle method and is preferred for use with unenriched water samples. Unit time may be either the hour or day, depending on the incubation period. (See also “Primary productivity”)

Primary productivity (oxygen method) is expressed as milligrams of oxygen per area per unit time [mg O/(m^2/time)] for periphyton and macrophytes or per volume [mg O/(m^3/time)] for phytoplankton. The oxygen method defines production and respiration rates as estimated from changes in the measured dissolved-oxygen concentration. The oxygen light- and dark-bottle method is preferred if the rate of primary production is sufficient for accurate measurements to be made within 24 hours. Unit time may be either the hour or day, depending on the incubation period. (See also “Primary productivity”)

Radioisotopes are isotopic forms of elements that exhibit radioactivity. Isotopes are varieties of a chemical element that differ in atomic weight but are very nearly alike in chemical properties. The difference arises because the atoms of the isotopic forms of an element differ in the number of neutrons in the nucleus; for example, ordinary chlorine is a mixture of isotopes having atomic weights of 35 and 37, and the natural mixture has an atomic weight of about 35.453. Many of the elements similarly exist as mixtures of isotopes, and a great many new isotopes have been produced in the operation of nuclear devices such as the cyclotron. There are 275 isotopes of the 81 stable elements, in addition to more than 800 radioactive isotopes.

Reach, as used in this report, is a length of stream that is chosen to represent a uniform set of physical, chemical, and biological conditions within a segment. It is the principal sampling unit for collecting physical, chemical, and biological data.

Recoverable from bed (bottom) material is the amount of a given constituent that is in solution after a representative sample of bottom material has been digested by a method (usually using an acid or mixture of acids) that results in dissolution of readily soluble substances. Complete dissolution of all bottom material is not achieved by the digestion treatment and thus the determination represents less than the total amount (that is, less than 95 percent) of the constituent in the sample. To achieve comparability of analytical data, equivalent digestion procedures would be required of all laboratories performing such analyses because different digestion procedures are likely to produce different analytical results. (See also “Bed material”)

Recurrence interval, also referred to as return period, is the average time, usually expressed in years, between occurrences of hydrologic events of a specified type (such as exceedances of a specified high flow or nonexceedance of a specified low flow). The terms “return period” and “recurrence interval” do not imply regular cyclic occurrence. The actual times between occurrences vary randomly, with most of the times being less than the average and a few being substantially greater than the average. For example, the 100-year flood is the flow rate that is exceeded by the annual maximum peak flow at intervals whose average length is 100 years (that is, once in 100 years, on average); almost two-thirds of all exceedances of the 100-year flood occur less than 100 years after the previous exceedance, half occur less than 70 years after the previous exceedance, and about one-eighth occur more than 200 years after the previous exceedance. Similarly, the 7-day, 10-year low flow ($7Q_{10}$) is the flow rate below which the annual minimum 7-day-mean flow dips at intervals whose average length is 10 years (that is, once in 10 years, on average); almost two-thirds of the nonexceedances of the $7Q_{10}$ occur less than 10 years after the previous nonexceedance, half occur less than 7 years after, and about one-eighth occur more than 20 years after the previous nonexceedance. The recurrence interval for annual events is the reciprocal of the annual probability of occurrence. Thus, the 100-year flood has a 1-percent chance of being exceeded by the maximum peak flow in any year, and there is a 10-percent chance in any year that the annual minimum 7-day-mean flow will be less than the $7Q_{10}$.

Replicate samples are a group of samples collected in a manner such that the samples are thought to be essentially identical in composition.

Return period (See "Recurrence interval")

Riffle, as used in this report, is a shallow part of the stream where water flows swiftly over completely or partially submerged obstructions to produce surface agitation.

River mileage is the curvilinear distance, in miles, measured upstream from the mouth along the meandering path of a stream channel in accordance with Bulletin No. 14 (October 1968) of the Water Resources Council and typically is used to denote location along a river.

Run, as used in this report, is a relatively shallow part of a stream with moderate velocity and little or no surface turbulence.

Runoff is the quantity of water that is discharged ("runs off") from a drainage basin during a given time period. Runoff data may be presented as volumes in acre-feet, as mean discharges per unit of drainage area in cubic feet per second per square mile, or as depths of water on the drainage basin in inches. (See also "Annual runoff")

Sea level, as used in this report, refers to one of the two commonly used national vertical datums (NGVD 1929 or NAVD 1988). See separate entries for definitions of these datums.

Sediment is solid material that originates mostly from disintegrated rocks; when transported by, suspended in, or deposited from water, it is referred to as "fluvial sediment." Sediment includes chemical and biochemical precipitates and decomposed organic material, such as humus. The quantity, characteristics, and cause of the occurrence of sediment in streams are affected by environmental and land-use factors. Some major factors are topography, soil characteristics, land cover, and depth and intensity of precipitation.

Sensible heat flux (often used interchangeably with latent sensible heat-flux density) is the amount of heat energy that moves by turbulent transport through the air across a specified cross-sectional area per unit time and goes to heating (cooling) the air. Usually expressed in watts per square meter.

Seven-day, 10-year low flow ($7Q_{10}$) is the discharge below which the annual 7-day minimum flow falls in 1 year out of 10 on the long-term average. The recurrence interval of the $7Q_{10}$ is 10 years; the chance that the annual 7-day minimum flow will be less than the $7Q_{10}$ is 10 percent in any given year. (See also "Annual 7-day minimum" and "Recurrence interval")

Shelves, as used in this report, are streambank features extending nearly horizontally from the flood plain to the lower limit of persistent woody vegetation.

Sodium adsorption ratio (SAR) is the expression of relative activity of sodium ions in exchange reactions within soil and is an index of sodium or alkali hazard to the soil. Sodium hazard in water is an index that can be used to evaluate the suitability of water for irrigating crops.

Soil heat flux (often used interchangeably with soil heat-flux density) is the amount of heat energy that moves by conduction across a specified cross-sectional area of soil per unit time and goes to heating (or cooling) the soil. Usually expressed in watts per square meter.

Soil-water content is the water lost from the soil upon drying to constant mass at 105 °C; expressed either as mass of water per unit mass of dry soil or as the volume of water per unit bulk volume of soil.

Specific electrical conductance (conductivity) is a measure of the capacity of water (or other media) to conduct an electrical current. It is expressed in microsiemens per centimeter at 25 °C. Specific electrical conductance is a function of the types and quantity of dissolved substances in water and can be used for approximating the dissolved-solids content of the water. Commonly, the concentration of dissolved solids (in milligrams per liter) is from 55 to 75 percent of the specific conductance (in microsiemens). This relation is not constant from stream to stream, and it may vary in the same source with changes in the composition of the water.

Stable isotope ratio (per MIL) is a unit expressing the ratio of the abundance of two radioactive isotopes. Isotope ratios are used in hydrologic studies to determine the age or source of specific water, to evaluate mixing of different water, as an aid in determining reaction rates, and other chemical or hydrologic processes.

Stage (See "Gage height")

Stage-discharge relation is the relation between the water-surface elevation, termed stage (gage height), and the volume of water flowing in a channel per unit time.

Streamflow is the discharge that occurs in a natural channel. Although the term "discharge" can be applied to the flow of a canal, the word "streamflow" uniquely describes the discharge in a surface stream course. The term "streamflow" is more general than "runoff" as streamflow may be applied to discharge whether or not it is affected by diversion or regulation.

Substrate is the physical surface upon which an organism lives.

Substrate embeddedness class is a visual estimate of riffle streambed substrate larger than gravel that is surrounded or covered by fine sediment (<2 mm, sand or finer). Below are the class categories expressed as the percentage covered by fine sediment:

0	no gravel or larger substrate	3	26-50 percent
1	> 75 percent	4	5-25 percent
2	51-75 percent	5	< 5 percent

Surface area of a lake is that area (acres) encompassed by the boundary of the lake as shown on USGS topographic maps, or other available maps or photographs. Because surface area changes with lake stage, surface areas listed in this report represent those determined for the stage at the time the maps or photographs were obtained.

Surficial bed material is the upper surface (0.1 to 0.2 foot) of the bed material that is sampled using U.S. Series Bed-Material Samplers.

Surrogate is an analyte that behaves similarly to a target analyte, but that is highly unlikely to occur in a sample. A surrogate is added to a sample in known amounts before extraction and is measured with the same laboratory procedures used to measure the target analyte. Its purpose is to monitor method performance for an individual sample.

Suspended (as used in tables of chemical analyses) refers to the amount (concentration) of undissolved material in a water-sediment mixture. It is defined operationally as the material retained on a 0.45-micrometer filter.

Suspended, recoverable is the amount of a given constituent that is in solution after the part of a representative suspended water-sediment sample that is retained on a 0.45-micrometer membrane filter has been digested by a method (usually using a dilute acid solution) that results in dissolution of only readily soluble substances. Complete dissolution of all the particulate matter is not achieved by the digestion treatment, and, thus, the determination represents something less than the "total" amount (that is, less than 95 percent) of the constituent present in the sample. To achieve comparability of analytical data, equivalent digestion procedures are required of all laboratories performing such analyses because different digestion procedures are likely to produce different analytical results. Determinations of "suspended, recoverable" constituents are made either by directly analyzing the suspended mate-rial collected on the filter or, more commonly, by difference, on the basis of determinations of (1) dissolved and (2) total recoverable concentrations of the constituent. (See also "Suspended")

Suspended sediment is the sediment maintained in suspension by the upward components of turbulent currents or that exists in suspension as a colloid. (See also "Sediment")

Suspended-sediment concentration is the velocity-weighted concentration of suspended sediment in the sampled zone (from the water surface to a point approximately 0.3 foot above the bed) expressed as milligrams of dry sediment per liter of water-sediment mixture (mg/L). The analytical technique uses the mass of all of the sediment and the net weight of the water-sediment mixture in a sample to compute the suspended-sediment concentration. (See also "Sediment" and "Suspended sediment")

Suspended-sediment discharge (tons/d) is the rate of sediment transport, as measured by dry mass or volume, that passes a cross section in a given time. It is calculated in units of tons per day as follows: concentration (mg/L) x discharge (ft^3/s) x 0.0027. (See also "Sediment," "Suspended sediment," and "Suspended-sediment concentration")

Suspended-sediment load is a general term that refers to a given characteristic of the material in suspension that passes a point during a specified period of time. The term needs to be qualified, such as "annual suspended-sediment load" or "sand-size suspended-sediment load," and so on. It is not synonymous with either suspended-sediment discharge or concentration. (See also "Sediment")

Suspended solids, total residue at 105 °C concentration is the concentration of inorganic and organic material retained on a filter, expressed as milligrams of dry material per liter of water (mg/L). An aliquot of the sample is used for this analysis.

Suspended, total is the total amount of a given constituent in the part of a water-sediment sample that is retained on a 0.45-micrometer membrane filter. This term is used only when the analytical procedure assures measurement of at least 95 percent of the constituent determined. Knowledge of the expected form of the constituent in the sample, as well as the analytical methodology used, is required to determine when the results should be reported as "suspended, total." Determinations of "suspended, total" constituents are made either by directly analyzing portions of the suspended material collected on the filter or, more commonly, by difference, on the basis of determinations of (1) dissolved and (2) total concentrations of the constituent. (See also "Suspended")

Synoptic studies are short-term investigations of specific water-quality conditions during selected seasonal or hydro-logic periods to provide improved spatial resolution for critical water-quality conditions. For the period and conditions sampled, they assess the spatial distribution of selected water-quality conditions in relation to causative factors, such as land use and contaminant sources.

Taxa (Species) richness is the number of species (taxa) present in a defined area or sampling unit.

Taxonomy is the division of biology concerned with the classification and naming of organisms. The classification of organisms is based upon a hierarchial scheme beginning with Kingdom and ending with Species at the base. The higher the classification level, the fewer features the organisms have in common. For example, the taxonomy of a particular mayfly, *Hexagenia limbata,* is the following:

Kingdom:	Animal
Phylum:	Arthropeda
Class:	Insecta
Order:	Ephemeroptera
Family:	Ephemeridae
Genus:	*Hexagenia*
Species:	*Hexagenia limbata*

Thalweg is the line formed by connecting points of minimum streambed elevation (deepest part of the channel).

Thermograph is an instrument that continuously records variations of temperature on a chart. The more general term "temperature recorder" is used in the table descriptions and refers to any instrument that records temperature whether on a chart, a tape, or any other medium.

Time-weighted average is computed by multiplying the number of days in the sampling period by the concentrations of individual constituents for the corresponding period and dividing the sum of the products by the total number of days. A time-weighted average represents the composition of water resulting from the mixing of flow proportionally to the duration of the concentration.

Tons per acre-foot (T/acre-ft) is the dry mass (tons) of a constituent per unit volume (acre-foot) of water. It is computed by multiplying the concentration of the constituent, in milligrams per liter, by 0.00136.

Tons per day (T/DAY, tons/d) is a common chemical or sediment discharge unit. It is the quantity of a substance in solution, in suspension, or as bedload that passes a stream section during a 24-hour period. It is equivalent to 2,000 pounds per day, or 0.9072 metric ton per day.

Total is the amount of a given constituent in a representative whole-water (unfiltered) sample, regardless of the constituent's physical or chemical form. This term is used only when the analytical procedure assures measurement of at least 95 percent of the constituent present in both the dissolved and suspended phases of the sample. A knowledge of the expected form of the constituent in the sample, as well as the analytical methodology used, is required to judge when the results should be reported as “total.” (Note that the word “total” does double duty here, indicating both that the sample consists of a water-suspended sediment mixture and that the analytical method determined at least 95 percent of the constituent in the sample.)

Total coliform bacteria are a particular group of bacteria that are used as indicators of possible sewage pollution. This group includes coliforms that inhabit the intestine of warmblooded animals and those that inhabit soils. They are characterized as aerobic or facultative anaerobic, gram-negative, nonspore-forming, rod-shaped bacteria that ferment lactose with gas formation within 48 hours at 35 °C. In the laboratory, these bacteria are defined as all the organisms that produce colonies with a golden-green metallic sheen within 24 hours when incubated at 35 °C plus or minus 1.0 °C on M-Endo medium (nutrient medium for bacterial growth). Their concentrations are expressed as number of colonies per 100 milliliters of sample. (See also “Bacteria”)

Total discharge is the quantity of a given constituent, measured as dry mass or volume, that passes a stream cross section per unit of time. When referring to constituents other than water, this term needs to be qualified, such as “total sediment discharge,” “total chloride discharge,” and so on.

Total in bottom material is the amount of a given constituent in a representative sample of bottom material. This term is used only when the analytical procedure assures measurement of at least 95 percent of the constituent determined. A knowledge of the expected form of the constituent in the sample, as well as the analytical methodology used, is required to judge when the results should be reported as “total in bottom material.”

Total length (fish) is the straight-line distance from the anterior point of a fish specimen’s snout, with the mouth closed, to the posterior end of the caudal (tail) fin, with the lobes of the caudal fin squeezed together.

Total load refers to all of a constituent in transport. When referring to sediment, it includes suspended load plus bed load.

Total organism count is the number of organisms collected and enumerated in any particular sample. (See also “Organism count/volume”)

Total recoverable is the amount of a given constituent in a whole-water sample after a sample has been digested by a method (usually using a dilute acid solution) that results in dissolution of only readily soluble substances. Complete dissolution of all particulate matter is not achieved by the digestion treatment, and thus the determination represents something less than the “total” amount (that is, less than 95 percent) of the constituent present in the dissolved and suspended phases of the sample. To achieve comparability of analytical data for whole-water samples, equivalent digestion procedures are required of all laboratories performing such analyses because different digestion procedures may produce different analytical results.

Total sediment discharge is the mass of suspended-sediment plus bed-load transport, measured as dry weight, that passes a cross section in a given time. It is a rate and is reported as tons per day. (See also “Bedload,” “Bedload discharge,” “Sediment,” “Suspended sediment,” and “Suspended-sediment concentration”)

Total sediment load or **total load** is the sediment in transport as bedload and suspended-sediment load. The term may be qualified, such as “annual suspended-sediment load” or “sand-size suspended-sediment load,” and so on. It differs from total sediment discharge in that load refers to the material, whereas discharge refers to the quantity of material, expressed in units of mass per unit time. (See also “Sediment,” “Suspended-sediment load,” and “Total load”)

Transect, as used in this report, is a line across a stream perpendicular to the flow and along which measurements are taken, so that morphological and flow characteristics along the line are described from bank to bank. Unlike a cross section, no attempt is made to determine known elevation points along the line.

Turbidity is the reduction in the transparency of a solution because of the presence of suspended and some dissolved substances. The measurement technique records the collective optical properties of the solution that cause light to be scattered and attenuated rather than transmitted in straight lines; the higher the intensity of scattered or attenuated light, the higher the value of the turbidity. Turbidity is expressed in nephelometric turbidity units (NTU). Depending on the method used, the turbidity units as NTU can be defined as the intensity of light of a specified wavelength scattered or attenuated by suspended particles or absorbed at a method specified angle, usually 90 degrees, from the path of the incident light. Currently approved methods for the measurement of turbidity in the USGS include those that conform to USEPA Method 180.1, ASTM D1889-00, and ISO 7027. Measurements of turbidity by these different methods and different instruments are unlikely to yield equivalent values.

Ultraviolet (UV) absorbance (absorption) at 254 or 280 nanometers is a measure of the aggregate concentration of the mixture of UV absorbing organic materials dissolved in the analyzed water, such as lignin, tannin, humic substances, and various aromatic compounds. UV absorbance (absorption) at 254 or 280 nanometers is measured in UV absorption units per centimeter of path length of UV light through a sample.

Unconfined aquifer is an aquifer whose upper surface is a water table free to fluctuate under atmospheric pressure. (See “Water-table aquifer”)

Vertical datum (See “Datum”)

Volatile organic compounds (VOCs) are organic compounds that can be isolated from the water phase of a sample by purging the water sample with inert gas, such as helium, and, subsequently, analyzed by gas chromatography. Many VOCs are human-made chemicals that are used and produced in the manufacture of paints, adhesives, petroleum products, pharmaceuticals, and refrigerants. They often are components of fuels, solvents, hydraulic fluids, paint thinners, and dry-cleaning agents commonly used in urban settings. VOC contamination of drinking-water supplies is a human-health concern because many are toxic and are known or suspected human carcinogens.

Water table is that surface in a ground-water body at which the water pressure is equal to the atmospheric pressure.

Water-table aquifer is an unconfined aquifer within which the water table is found.

Water year in USGS reports dealing with surface-water supply is the 12-month period October 1 through September 30. The water year is designated by the calendar year in which it ends and which includes 9 of the 12 months. Thus, the year ending September 30, 2002, is called the "2002 water year."

Watershed (See "Drainage basin")

WDR is used as an abbreviation for "Water-Data Report" in the REVISED RECORDS paragraph to refer to State annual hydrologic-data reports. (WRD was used as an abbreviation for "Water-Resources Data" in reports published prior to 1976.)

Weighted average is used in this report to indicate discharge-weighted average. It is computed by multiplying the discharge for a sampling period by the concentrations of individual constituents for the corresponding period and dividing the sum of the products by the sum of the discharges. A discharge-weighted average approximates the composition of water that would be found in a reservoir containing all the water passing a given location during the water year after thorough mixing in the reservoir.

Wet mass is the mass of living matter plus contained water. (See also "Biomass" and "Dry mass")

Wet weight refers to the weight of animal tissue or other substance including its contained water. (See also "Dry weight")

WSP is used as an acronym for "Water-Supply Paper" in reference to previously published reports.

Zooplankton is the animal part of the plankton. Zooplankton are capable of extensive movements within the water column and often are large enough to be seen with the unaided eye. Zooplankton are secondary consumers feeding upon bacteria, phytoplankton, and detritus. Because they are the grazers in the aquatic environment, the zooplankton are a vital part of the aquatic food web. The zooplankton community is dominated by small crustaceans and rotifers. (See also "Plankton")

TECHNIQUES OF WATER-RESOURCES INVESTIGATIONS OF THE U.S. GEOLOGICAL SURVEY

The USGS publishes a series of manuals, the Techniques of Water-Resources Investigations, describing procedures for planning and conducting specialized work in water-resources investigations. The material is grouped under major subject headings called books and is further divided into sections and chapters. For example, section A of book 3 (Applications of Hydraulics) pertains to surface water. The chapter, the unit of publication, is limited to a narrow field of subject matter. This format permits flexibility in revision and publication as the need arises.

Reports in the Techniques of Water-Resources Investigations series, which are listed below, are online at *http://water.usgs.gov/pubs/twri/*. Printed copies are for sale by the USGS, Information Services, Box 25286, Federal Center, Denver, Colorado 80225 (authorized agent of the Superintendent of Documents, Government Printing Office), telephone 1-888-ASK-USGS. Please telephone 1-888-ASK-USGS for current prices, and refer to the title, book number, chapter number, and mention the "U.S. Geological Survey Techniques of Water-Resources Investigations." Products can then be ordered by telephone, or online at http://www.usgs.gov/sales.html, or by FAX to (303)236-469 of an order form available online at *http://mac.usgs.gov/isb/pubs/forms/*. Prepayment by major credit card or by a check or money order payable to the "U.S. Geological Survey" is required.

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Section D. Water Quality

1–D1. *Water temperature—Influential factors, field measurement, and data presentation*, by H.H. Stevens, Jr., J.F. Ficke, and G.F. Smoot: USGS–TWRI book 1, chap. D1. 1975. 65 p.

1–D2. *Guidelines for collection and field analysis of ground-water samples for selected unstable constituents*, by W.W. Wood: USGS–TWRI book 1, chap. D2. 1976. 24 p.

Book 2. Collection of Environmental Data

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2–D1. *Application of surface geophysics to ground-water investigations,* by A.A.R. Zohdy, G.P. Eaton, and D.R. Mabey: USGS–TWRI book 2, chap. D1. 1974. 116 p.

2–D2. *Application of seismic-refraction techniques to hydrologic studies,* by F.P. Haeni: USGS–TWRI book 2, chap. D2. 1988. 86 p.

Section E. Subsurface Geophysical Methods

2–E1. *Application of borehole geophysics to water-resources investigations,* by W.S. Keys and L.M. MacCary: USGS–TWRI book 2, chap. E1. 1971. 126 p.

2–E2. *Borehole geophysics applied to ground-water investigations,* by W.S. Keys: USGS–TWRI book 2, chap. E2. 1990. 150 p.

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Book 3. Applications of Hydraulics

Section A. Surface-Water Techniques

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3–A2. *Measurement of peak discharge by the slope-area method,* by Tate Dalrymple and M.A. Benson: USGS–TWRI book 3, chap. A2. 1967. 12 p.

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3–A6. *General procedure for gaging streams,* by R.W. Carter and Jacob Davidian: USGS–TWRI book 3, chap. A6. 1968. 13 p.

3–A7. *Stage measurement at gaging stations,* by T.J. Buchanan and W.P. Somers: USGS–TWRI book 3, chap. A7. 1968. 28 p.

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3–A9. *Measurement of time of travel in streams by dye tracing,* by F.A. Kilpatrick and J.F. Wilson, Jr.: USGS–TWRI book 3, chap. A9. 1989. 27 p.

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3–A20. *Simulation of soluble waste transport and buildup in surface waters using tracers*, by F.A. Kilpatrick: USGS–TWRI book 3, chap. A20. 1993. 38 p.

3–A21 *Stream-gaging cableways,* by C. Russell Wagner: USGS–TWRI book 3, chap. A21. 1995. 56 p.

Section B. Ground-Water Techniques

3–B1. *Aquifer-test design, observation, and data analysis,* by R.W. Stallman: USGS–TWRI book 3, chap. B1. 1971. 26 p.

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