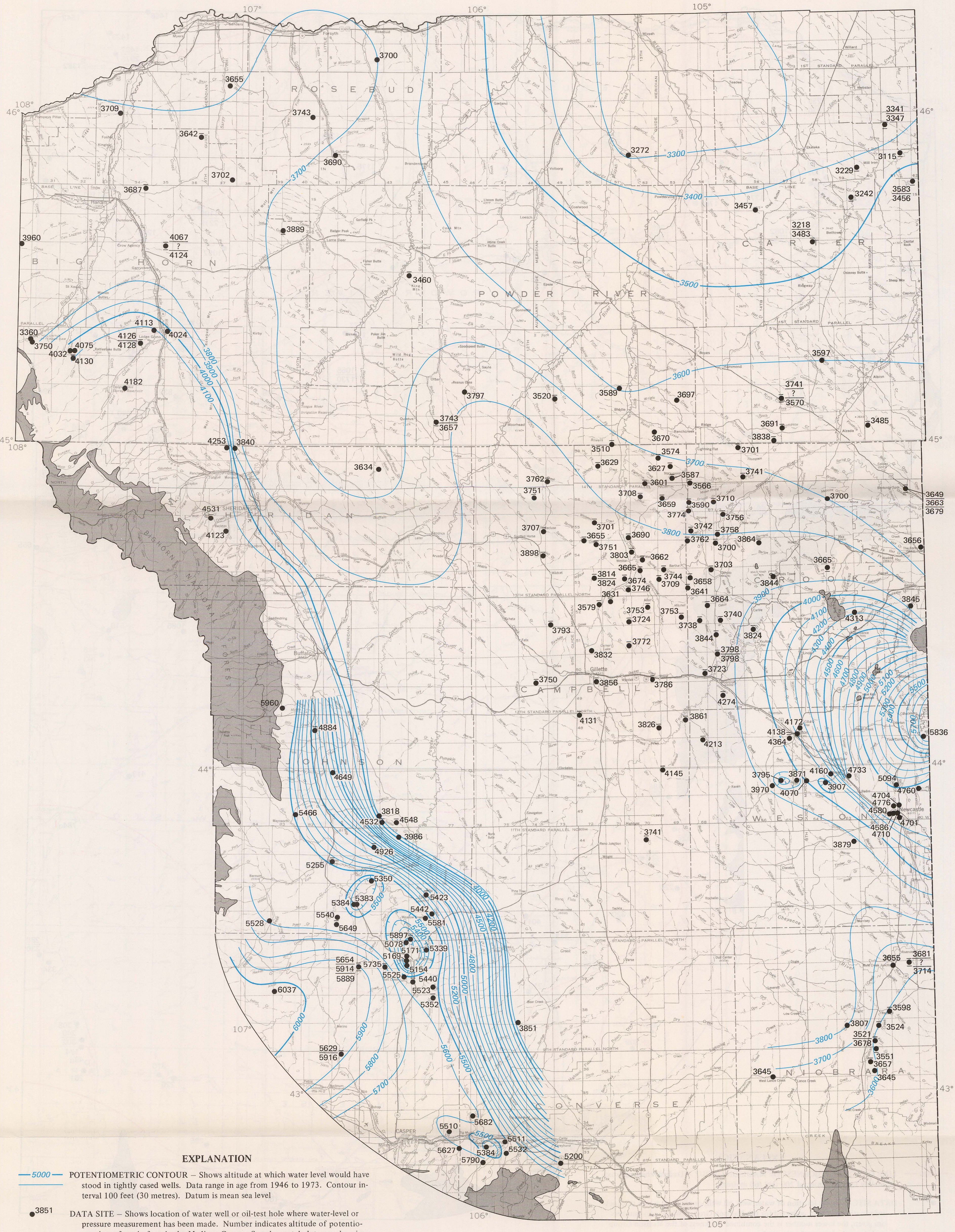
Prepared in cooperation with the
MONTANA BUREAU OF MINES AND GEOLOGY
AND THE WYOMING STATE ENGINEER



EXPLANATION

5000 — POTENTIOMETRIC CONTOUR – Shows altitude at which water level would have stood in tightly cased wells. Data range in age from 1946 to 1973. Contour interval 100 feet (30 metres). Datum is mean sea level

●3851 DATA SITE – Shows location of water well or oil-test hole where water-level or pressure measurement has been made. Number indicates altitude of potentiometric surface, in feet, in the Madison Group. Supplemental data are also given at some sites for the rocks overlying the Madison (Tensleep Sandstone, Minnelusa or Amsden Formation) and for carbonate rocks underlying the Madison (Bighorn Dolomite or Red River Formation). Supplemental data were not used to construct contours. Supplemental data for the overlying rocks and for the underlying rocks are shown by the following symbols

4145 Rock units overlying the Madison. Where two numbers are given, the lower number is for the Madison

3889 Rock units underlying the Madison. Where two numbers are given, the upper number is for the Madison

3649 / 3663 / 3679 Upper number is for the overlying rock units; middle number is for the Madison; and lower number is for the underlying rock units

AREA WHERE MADISON GROUP IS ABSENT

Hydrology by W. G. Hodson, F. A. Swenson, W. R. Miller, and F. N. Visher, 1975

MAP SHOWING PRELIMINARY CONCEPT OF POTENTIOMETRIC SURFACE OF WATER IN THE MADISON GROUP, WITH SUPPLEMENTAL DATA FOR OVERLYING AND UNDERLYING ROCK UNITS

POTENTIOMETRIC SURFACE

The potentiometric-surface map was prepared from drill-stem tests, depth-to-water measurements, and pressure-gage readings on shut-in wells bottomed in the Madison. The map also shows potentiometric heads recorded for selected rock units overlying and underlying the Madison. The similarity of potentiometric heads in the Madison with those in the overlying and underlying rocks at many places indicates that these rocks are in hydraulic connection in much of the basin.

The drill-stem tests, shut-in pressures, and water-level measurements were made over a period of 27 years. Therefore, the potentiometric surface, as shown on the map, may not reflect the actual water surface at any given time.

The potentiometric map indicates that recharge to the Madison occurs in outcrop areas of the Bighorn and Pryor Mountains on the west side of the basin, the Black Hills on the east, and the Laramie Mountains on the south. In general, the gradient is basinward from the recharge areas and then to the north and northeast. Some movement is to the southeast around the south end of the Black Hills. The potentiometric gradient is steep on the west and southwest flanks of the basin, and on the flanks of the Black Hills. Offset of the aquifer on the western and southern flanks of the basin by faulting may, in part, account for the steep gradient at these locations. Data are not available in the central part of the basin; thus, the configuration of the potentiometric surface and the resultant movement of water in this part of the basin are conjectural. The relatively flat gradient implied in the central part of the basin could indicate that either the quantity of underflow is small or the transmissivity is high.

WATER AVAILABILITY

Most of the water wells completed in the Madison are on or near the flanks of the basin. Water wells have not been drilled to the Madison in the deepest parts of the basin. Drill-stem tests of some oil exploration wells, however, have indicated high permeability at depths exceeding 12,000 feet (3,660 m) below land surface. The deepest known water well, north of Glenrock, Wyo., (sec. 7, T. 34 N., R. 76 W.) is 10,847 feet (3,310 m) deep and has been pumped at a rate of 330 gal/min (21 l/s).

Water was first withdrawn from the Madison in 1917 when the Tisdale oil test (sec. 16, T. 41 N., R. 81 W.) near Midwest, Wyo., was completed as a water well flowing about 4,000 gal/min (250 l/s) of good quality water. Since then 13 additional Madison wells have been drilled in the Midwest area to supply water for secondary recovery of oil. The deepest (sec. 11, T. 52 N., R. 78 W.) is 10,040 feet (3,060 m) deep and had an initial yield of 720 gal/min (45 l/s). Data for seven Madison water wells in the Midwest area show an average initial yield of 3,800 gal/min (240 l/s). Initial yields of these seven wells ranged from 430 gal/min (27 l/s) to an estimated 9,000 gal/min (570 l/s). Use of water from the Madison in the Midwest area has reduced the pressure surface more than 400 feet (120 m) and the area of influence now extends under at least four townships.

Withdrawal of water from the Madison at the south end of the basin near Glenrock, Wyo., has resulted in another area of declining water levels. Yields of Madison wells in the Glenrock area are not as large as at Midwest and fewer Madison wells have been drilled; consequently, the area of water-level decline is smaller.

Another area of water development in the Madison is near Newcastle, Wyo., where two cones of depression have developed. Madison water has been used in the Newcastle area for industrial and municipal purposes since 1961. One well near Newcastle (sec. 28, T. 45 N., R. 61 W.) had a specific capacity of 15 (gal/min)/ft [3.1 (l/s)/m] of drawdown and a shut-in pressure at land surface of 107 lb/in² (7.52 kg/cm²) when the well was completed in 1965. These data indicate that the well might have flowed about 4,000 gal/min (250 l/s), neglecting friction losses. The transmissivity has been estimated from these data to be about 4,000 (ft³/d)/ft [372 (m³/d)/m], for the 43 feet (13 m) of Madison penetrated by the well.

In the Bell Creek oil field of southern Montana, four water wells have been completed in the Madison at depths of 6,960 to 7,296 feet (2,120 to 2,220 m). The maximum measured yield of one of these wells (sec. 21, T. 8 S., R. 54 E.) was about 1,300 gal/min (82 l/s). The transmissivity of the aquifer computed from a test of one well was 5,400 (ft³/d)/ft [500 (m³/d)/m].

The yields from individual water wells can be expected to range widely. For example, the specific capacities of 24 wells (table) in the Wyoming part of the Powder River Basin range from 0.25 (gal/min)/ft [0.052 (l/s)/m] of drawdown to 49 (gal/min)/ft [10 (l/s)/m] of drawdown.

WATER USE

According to the Wyoming State Engineer (1974) about 25,000 acre-ft (31 million m³) of water was withdrawn from the Madison in the Wyoming part of the Powder River Basin in 1973. The Madison is the principal source of water for secondary recovery of oil in the Powder River Basin in Wyoming. More than 20,000 acre-ft (25 million m³) was used for secondary recovery of oil, and about 3,000 acre-ft (3.7 million m³) was used for municipal water supplies. Other use of water from the Madison includes about 1,000 acre-ft (1.2 million m³) per year in the Osage-Newcastle area for electric power generation and for oil refinery water requirements.

Water from the Madison is used for industrial purposes in the Montana part of the Powder River Basin. Four Madison water wells supplied about 3,600 acre-ft (4.4 million m³) of water in 1973 for secondary recovery of oil at the Bell Creek field (T. 8–9 S., R. 53–55 E.). One Madison water well at Sarpy Creek (sec. 26, T. 1 N., R. 37 E.) and one at Colstrip (sec. 34, T. 2 N., R. 41 E.) supply water for coal-mining operations. The amount of water withdrawn from these two wells is estimated to be less than 200 acre-ft (0.25 million m³) per year.

WATER QUALITY

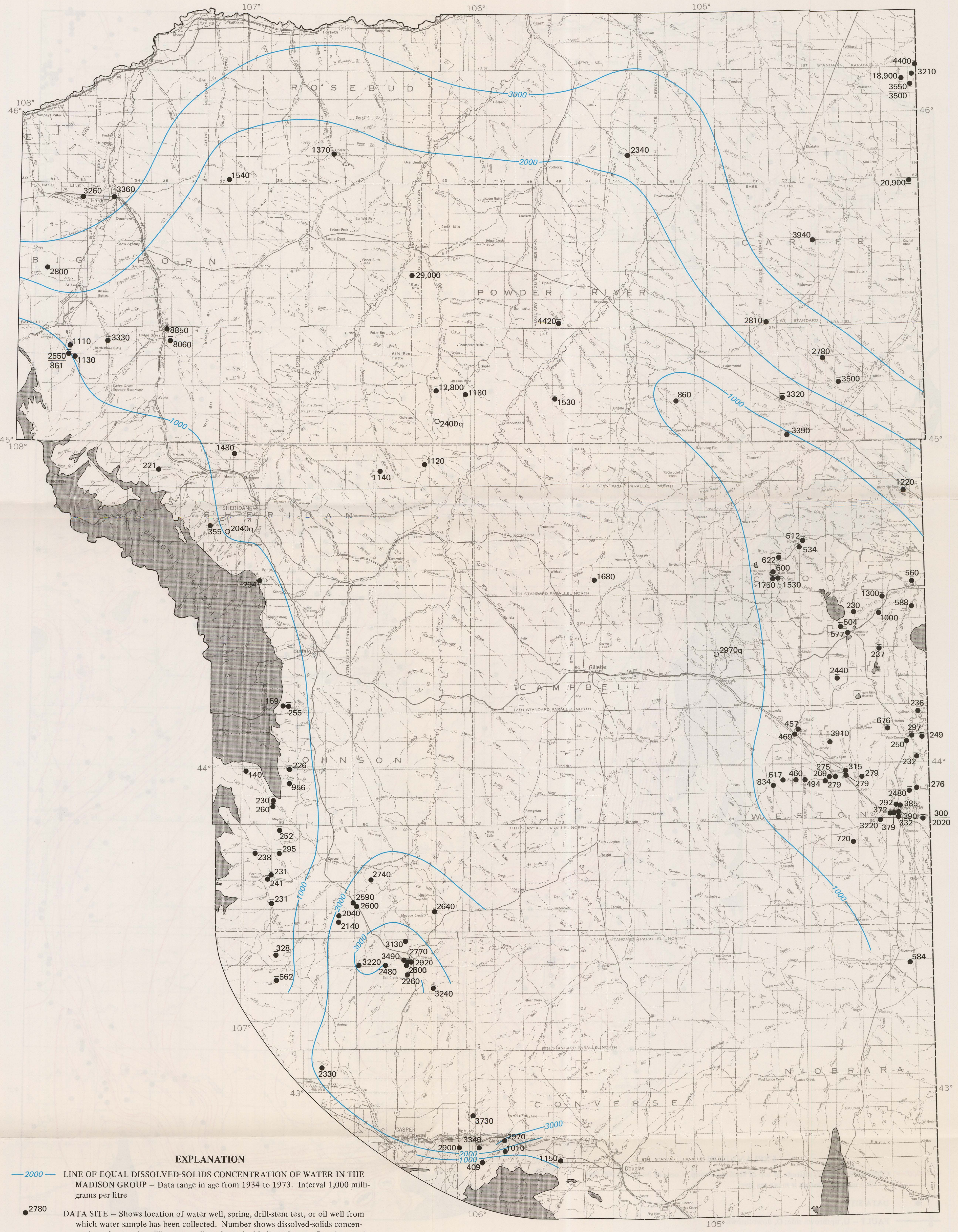
The dissolved-solids concentration in samples of water from the Madison and both the overlying and underlying rocks is shown on the concentration map. The lines of equal concentration for water from the Madison are based on analyses of water samples from water wells, springs, drill-stem tests, and producing oil wells. Samples obtained from the drill-stem tests and oil wells may not represent typical aquifer water; the amount of dissolved solids may be different because of contamination during drilling or because of restricted ground-water circulation in and near oil fields.

Although the number of water samples from the Madison in the Powder River Basin is not large, a trend is apparent. The Madison has yielded water containing less than 1,000 mg/l (milligrams per litre) dissolved solids near recharge areas, such as along the flanks of the Black Hills and the Bighorn Mountains. Good quality water also extends northwest from the Black Hills into southeast Montana, where from a depth of 7,190 feet (2,190 m) in a well in sec. 21, T. 8 S., R. 54 E. the Madison yielded water containing 860 mg/l dissolved solids.

The Madison yielded water containing 3,730 mg/l dissolved solids from a depth of 10,847 feet (3,310 m) in a well in sec. 7, T. 34 N., R. 76 W. near Glenrock, Wyo. Water from the Madison contained 2,640 mg/l dissolved solids from a depth of 10,020 feet (3,050 m) in a well in sec. 1, T. 41 N., R. 78 W. near Midwest, Wyo. Three water samples from the Madison at depths of about 11,000 feet (3,350 m), obtained by drill-stem tests for oil-exploration wells in the north-central part of the basin northeast of Sheridan, Wyo., contained about 1,150 mg/l dissolved solids. From the limited data available, the Madison Group appears to be capable of yielding water containing less than 2,000 mg/l dissolved solids in much of the outer margins of the Powder River Basin, especially in the southern part. No data are available, however, regarding water quality in the Madison in the central, deeper part of the basin.

SPECIFIC CAPACITIES OF SELECTED WATER WELLS IN THE MADISON GROUP, POWDER RIVER BASIN, WYOMING

Location	Use of well	Depth of well (feet)	Date of test	Duration of test	Well discharge (gal/min)	Drawdown (feet)	Specific capacity [(gal/min)/ft of drawdown]	Estimated thickness of formation (feet)	Amount of formation that well penetrated (feet)
Midwest area									
SE¼NE¼ sec. 2, T. 40 N., R. 79 W.	Oil-field waterflood	7,467	Apr. 1971	(?)	297	286	1.0	350	all
			July 1971	(?)	320	292	1.1		
			Oct. 1971	(?)	359	298	1.2		
			Jan. 1972	(?)	336	274	1.2		
SE¼SE¼ sec. 23, T. 40 N., R. 79 W.	Oil-field waterflood	5,049	Apr. 1971	(?)	726	133	5.5	350	all
			July 1971	(?)	706	100	7.1		
			Oct. 1971	(?)	684	122	5.6		
			Jan. 1972	(?)	491	112	4.4		
NE¼SW¼ sec. 26, T. 40 N., R. 79 W.	Oil-field waterflood	4,889	Apr. 1971	(?)	5,599	182	31	350	214
			July 1971	(?)	5,110	202	25		
			Oct. 1971	(?)	4,580	163	28		
			Jan. 1972	(?)	4,121	152	27		
SW¼NE¼ sec. 35, T. 40 W., R. 79 W.	Oil-field waterflood	4,975	Apr. 1971	(?)	1,700	35	49	310	281
			July 1971	(?)	4,000	176	23		
			Oct. 1971	(?)	6,000	296	20		
			Jan. 1972	(?)	7,200	418	17		
SW¼SW¼ sec. 35, T. 40 N., R. 79 W.	Oil-field waterflood	4,968	Apr. 1971	(?)	593	23	26	310	291
			July 1971	(?)	650	25	26		
			Oct. 1971	(?)	577	17	34		
			Jan. 1972	(?)	482	11	44		
South of Kaycee area									
NW¼NE¼ sec. 19, T. 41 N., R. 84 W.	Stock water	424	1963	3 hours	15	60	.25	200	all
NE¼SE¼ sec. 34, T. 43 N., R. 80 W.	Oil-field waterflood	9,300	June 1973	(?)	170	139	1.2	340	all
			June 1973	(?)	315	219	1.4		
Black Hills area									
NE¼SW¼ sec. 26, T. 44 N., R. 63 W.	Unused	6,881	June 1967	5 hours	250	175	1.4	400	all
SW¼SE¼ sec. 20, T. 45 N., R. 61 W.	Municipal	2,638	(?)	(?)	600	173	3.5	400	26
			(?)	(?)	1,000	277	3.6		
			(?)	(?)	1,500	462	3.2		
NW¼SW¼ sec. 21, T. 45 N., R. 61 W.	Municipal	2,872	Apr. 1966	72 hours	460	200	2.3	400	all
NW¼NE¼ sec. 28, T. 45 N., R. 61 W.	Commercial	2,738	July 1965	(?)	276	18	15	400	43
SE¼NW¼ sec. 19, T. 46 N., R. 64 W.	Plugged & abandoned	7,542	1956(?)	(?)	280	80	3.5	450	428
SW¼SW¼ sec. 23, T. 46 N., R. 64 W.	Unused	5,125	1965	6 hours	70	65	1.1	450	all
			June 1972	several weeks	308	293	1.1		
SE¼SW¼ sec. 20, T. 46 N., R. 65 W.	Oil-field waterflood	8,109	Sept. 1960	6 hours	425	295	1.4	450	369
NE¼NW¼ sec. 23, T. 46 N., R. 65 W.	Oil-field waterflood	7,737	1972	2 months	225	76	3.0	450	400
NW¼SE¼ sec. 25, T. 46 N., R. 66 W.	Oil-field waterflood	8,780	1972	4 months	360	211	1.7	450	390
SW¼SW¼ sec. 25, T. 48 N., R. 65 W.	Municipal	3,161	June 1972	6 hours	210	110	1.9	500	261
SW¼SW¼ sec. 35, T. 48 N., R. 65 W.	Municipal	3,193	June 1972	5 hours	155	101	1.5	500	464
SW¼SE¼ sec. 25, T. 52 N., R. 63 W.	Municipal	1,123	1972	24 hours	200	74	2.7	550	23
NW¼NW¼ sec. 18, T. 53 N., R. 65 W.	Public	1,341	1962	140 minutes	15	1	15	600	42
				80 minutes	25	4	6.2		
				120 minutes	30	6	5.0		
				110 minutes	37	9	4.1		
				95 minutes	40	10	4.0		
				12 hours	45	13	3.5		
				16 hours	55	19	2.9		
Glenrock area									
NW¼SE¼ sec. 8, T. 33 N., R. 75 W.	Oil-field waterflood	8,591	1963	168 hours	510	800	.64	250	235
NW¼SW¼ sec. 33, T. 33 N., R. 76 W.	Oil-field waterflood	8,770	Jan. 1962	(?)	75	16	4.7	250	240
			Jan. 1962	(?)	220	53	4.1		
			Jan. 1962	(?)	320	92	3.5		
Northeast Niobrara County area									
NW¼NE¼ sec. 28, T. 36 N., R. 62 W.	Test well	3,116	May 1974	179 minutes	104	217	.48	250	all
			May 1974	204 minutes	180	386	.47		
NE¼NE¼ sec. 2, T. 39 N., R. 61 W.	Test well	2,899	1962	(?)	30	36	.83	300	81



EXPLANATION

2000 — LINE OF EQUAL DISSOLVED-SOLIDS CONCENTRATION OF WATER IN THE MADISON GROUP – Data range in age from 1934 to 1973. Interval 1,000 milligrams per litre

●2780 DATA SITE – Shows location of water well, spring, drill-stem test, or oil well from which water sample has been collected. Number shows dissolved-solids concentration of water, in milligrams per litre, from the Madison Group. Supplemental data are also given at some sites for the rock units overlying the Madison (Tensleep Sandstone or Minnelusa Formation) and for carbonate-rock units underlying the Madison (Bighorn Dolomite or Red River Formation). Supplemental data were not used to construct lines. Supplemental data for the overlying rock units and for the underlying rock units are shown by the following symbols

3500 Rock units overlying the Madison. Where two numbers are given, the lower number is for the Madison

3550 Rock units underlying the Madison. Where two numbers are given, the upper number is for the Madison

○2970q Questionable data, not used to construct lines

AREA WHERE MADISON GROUP IS ABSENT

Hydrology by F. N. Visher, F. A. Swenson, W. R. Miller, and W. G. Hodson, 1975

MAP SHOWING DISSOLVED-SOLIDS CONCENTRATION IN WATER FROM THE MADISON GROUP, WITH SUPPLEMENTAL DATA ON WATER FROM OVERLYING AND UNDERLYING ROCK UNITS

Interior—Geological Survey, Reston, Va.—1976

Base from U.S. Geological Survey
State base maps, Montana and
Wyoming, 1:500,000

SCALE 1:1 000 000

25 0 25 50 75 100 MILES

25 0 25 50 75 100 KILOMETRES

MAP SHOWING POTENTIOMETRIC SURFACE OF WATER AND WATER QUALITY IN THE MADISON GROUP, POWDER RIVER BASIN, WYOMING AND MONTANA

By

F. A. Swenson, W. R. Miller, W. G. Hodson, and F. N. Visher

1976