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Development of ground water in the vicinity of Tensleep, Wyoming

By

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Introduction

The investigation in the Tensleep area was made to determine the extent of recent ground-water development and the effects of development on artesian pressures in the area.

The study was made by the U.S. Geological Survey in cooperation with the office of the Wyoming State Engineer as a part of a continuing ground-water program, which includes periodic investigation of ground-water conditions in areas of heavy withdrawal. The investigation was under the direct supervision of Ellis D. Gordon, district geologist, in charge of ground-water investigations in Wyoming.

Area of investigation

The area of investigation (fig. 1) is a belt about 48 miles long

Figure 1.--Geologic map of the Tensleep area, Wyoming, showing locations of wells and springs.

and 18 miles wide parallel to the Bighorn Mountains in Big Horn and Washakie Counties, Wyoming. The town of Tensleep is approximately in the center of the area. The limits of the study area were chosen to include wells in which artesian pressures had been measured previously in order that the pressures could be compared.

Methods of investigation

Field work was done during May 1962. All the new large-capacity wells were inventoried, but no attempt was made to collect data on all wells in the area. Wells inventoried in October and November 1953 were revisited, and artesian pressures were measured wherever possible.

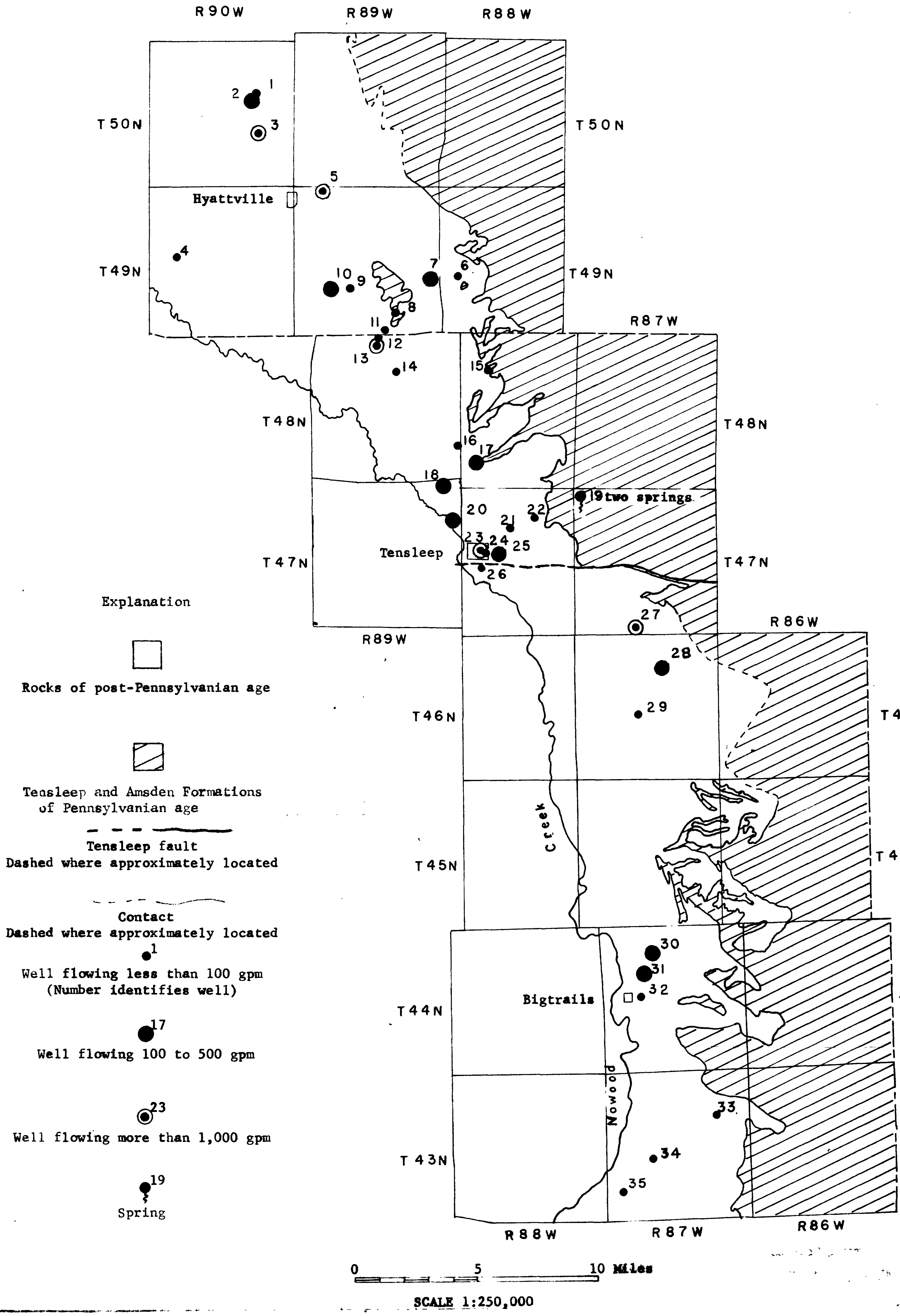

Figure 1.--Geologic map of the Tensleep area, Wyoming, showing locations of wells and springs.

Occurrence and development of ground water

The aquifers with which this report is concerned are a sequence of four formations. From oldest to youngest, these formations are the Bighorn Dolomite of Late Ordovician age, the Madison Limestone of Early and Late Mississippian age, and the Amsden Formation and the Tensleep Sandstone, both of Pennsylvanian age. The Bighorn Dolomite is a gray massive siliceous dolomite about 300 feet thick. The Madison Limestone consists of a sequence of nearly 800 feet of massive thick-bedded crystalline limestone and dolomite. The Amsden Formation is about 175 feet thick and consists of varicolored dolomite with thin beds of shale and shaly sandstone. Overlying the Amsden Formation is the Tensleep Sandstone, which is principally a light colored sandstone with dolomite in its lower part. Recharge to the formations occurs in the outcrop area along the western flank of the Bighorn Mountains.

The Tensleep Sandstone is the only aquifer in the report area in which the primary permeability--permeability due to interstices formed contemporaneously with the rock--is great enough to furnish even moderate supplies of ground water to wells. The large yield of well 31 is due in large part to the steep dip of the Tensleep Sandstone, which increases the thickness of sandstone penetrated. (See table 1.) The permeability of the Amsden, Madison, and Bighorn Formations is largely secondary--that permeability due to processes affecting the rocks after deposition. Differences in the secondary permeability, which can occur in short distances, accounts for the large differences in the yields of wells that penetrate these formations. Wells 7 and 30, both of which were drilled completely through the Madison Limestone and at least partly through the Bighorn Dolomite, have yields considerably smaller than wells 3, 5, and 23, none of which penetrated more than 210 feet of the Madison.

Wells with high yields commonly are associated with some structural feature where fracturing and subsequent solution has increased the permeability. Wells 3 and 13 were drilled as oil tests, and the large yields of water from these wells is due to the secondary permeability related to the structure on which the oil tests were drilled. The large yield of well 23, and possibly of well 27, probably is due to secondary permeability related to the Tensleep fault (fig. 1).

Table 1.--Record of wells and springs in the Tensleep area, Wyoming.

Location: Township and range (49-88, Township 49 North, Range 88 West), section and quarters (-28cb, southwest quarter of the northwest quarter, section 28).

Yield: E, estimated; M, measured; R, reported.

Geologic source: Pt, Tensleep Sandstone; Pa, Amsden Formation; Mm, Madison Limestone; Ob, Bighorn Dolomite.

Use of water: D, domestic; I, irrigation; In, industrial; N, none; P, public supply; S, stock.

Artesian pressure: R, reported.

Remarks: C, chemical analysis in table 2; D, dual completion; T, transmissibility in gallons per day per foot of aquifer.

Well or spring no. (fig. 1)	Location[a]	Owner or tenant	Year drilled	Source of water	Depth of well (feet)	Diameter of casing (inches)	Yield (gallons per minute)	Geologic source	Use of water	Artesian pressure (pounds per square inch) Static	After 5 minutes recovery	Date of measurement	Remarks
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
1	50-90-14a	Stanley Walters.....	1953	Well	2,000(?)	6	49 M	Pt,Pa,Mm	S	100	65	11- 7-53	C,T446
											82	5-12-62	
2	50-90-14ba	........do..........	----	.. do..	1,625	5 1/2	200 R	Pt	D,S,I	------	------	--------	C,T1,060
3	50-90-23dc	Walters Bros........	1956	..do...	2,500	5 1/2	2,880	Mm	S,I	350 R	230	5-14-62	
4	49-90-17cc	B. Bader............	1917	..do...	1,965±	6	30 E	----------	I	------	------	--------	
5	49-89- 5bb	R. C. Pearce........	1962	..do...	2,214	-----	2,500 R	Mm	I	170	------	5-11-62	
6	49-88-28cb	Homer Renner........	----	..do...	40	-----	35 R	Pt	S	------	------	--------	
7	49-89-24dc	........do..........	1936	..do...	570	6	200 R	Pt	S,I	------	------	--------	C
			1960	..do...	1,480	-----	200 M	Pt,Pa,Mm,Ob(?)	-----	51.5	42	5-12-62	Deepened,T5,000
8	49-89-35bb	........do..........	----	..do...	------	5	84 M	Mm	I	------	------	11- 2-53	C
9	49-89-28ba	........do..........	----	..do...	944	4	84 M	Mm	I	127	------	11- 4-53	C,T540

Table 1.--Record of wells and springs in the Tensleep area, Wyoming--continued

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
10	49-89-29ab	Clarke Gapen........	1951	Well	960	8	108 M	----------	S,I	107	------	11- 5-53	C,T890
										120	------	5-14-62	
11	49-89-34dc	Homer Renner........	----	..do...	360	6	45 R	₱t	I	------	------	--------	
12	48-89- 4ab	.........do..........	1950	..do...	470	6	50 R	₱t	S	------	-------	--------	
13	48-89- 4ac	........do..........	1959	..do...	1,362	7	2,500 R	Mm	I	------	135	5-10-62	
14	48-89-10	........do..........	----	..do...	420	6	20 R	₱t	S	44	------	11- 3-53	
15	48-88- 9bd	Vernon Rice.........	1951	..do...	-------	-----	5 E	₱t(?)	-----	------	------	--------	C
16	48-89-25da	Milo Mills..........	----	..do...	-------	-----	-------	----------	D	28	------	11-10-53	
										32	------	5-14-62	
17	48-88-28cc	Sie Davis...........	----	..do...	-------	-----	100 E	----------	S	------	------	11- -53	
18	47-89- 1b	J. E. Brown.........	1957	..do...	775	5	250R	₱t	D,S,I	------	------	--------	
19a	47-87- 6c1	State of Wyoming....	----	Spring	-------	------	900 E	₱t	In	------	------	--------	C
19b	47-87- 6c2	........do..........	----	Spring	-------	------	900 E	₱t	In	------	------	--------	C
20	47-89-12db	L. J. Davis.........	----	..do...	901	6	181 M	₱t	I	143	------	10-30-53	C,Tl,230
21	47-88-10ca	J. C. Frison & Sons.	----	..do...	-------	4	2 E	₱t	S	------	------	--------	
22	47-88-11ba	L. J. Davis	----	..do...	520	6	50 E	₱a	S	------	------	--------	
23	47-88-16cb	Town of Tensleep....	1955	..do...	1,050	5	1,100 R	₱a,Mm	P	135 R	------	--------	C,D
								₱t	N	80	------	5-10-62	
24	47-88-16ca	Paul Frison.........	----	..do...	505	4	-------	₱t	D,P	------	32	5-14-62	
25	47-88-16da	Rouse Anderson......	1942	..do...	227	6 1/2	150 R	₱t	I	------	------	--------	
26	47-88-21bb	Mills - Sweet.......	1942	..do...	758	5	5 R	₱t	D,S	------	------	--------	C
27	47-87-33	C. E. Tolman........	1959(?)	..do...	1,585	7	1,800 R	Mm,Ob	I	------	------	--------	D
28	46-87-10ac	Taylor Bros.........	1958	..do...	1,410	5	380 M	Mm	I	170 R		5- 9-62	
29	46-87-21ac	Robert Taylor.......	----	..do...	912	6	9.7M	₱t	D,I	45	------	10-31-53	C
			1960	..do...	1,100(?)	-----	------	----------	-----	------	70	5- 9-62	Deepened

Table 1.--Record of wells and springs in the Tensleep area, Wyoming--continued

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
30	44-87- 9bb	Greet Bros..........	1961	Well	1,820	5	260 M	Pt,Pa,Mm,Ob	I	115	------	5- 9-62	
31	44-87- 8dd	Bert H. Ainsworth	1952	..do...	1,040	-----	462 M	Pt	D,I	72	------	11-11-53	C,T3,007
										75	------	5-14-62	
32	44-87-17dd	R. C. Mills.........	----	..do...	450	-----	20 E	Pt	D,S	25	------	11-12-53	C
											23.5	5- 9-62	
33	43-87-11dc	George Woods........	----	..do...	443	6	17.3M	Pt	-----	6	------	11-12-53	C
										7 R	------	....1961..	
34	43-87-20da	Dexter Bush.........	----	..do...	--------	8	-------	----------	-----	15 3/4	------	11-12-53	C
										10 1/2	------	5-7-62	
35	43-87-30dc	Tolman..............	1943(?)	..do...	--------	4	------	----------	------	62	------	11-12-53	
										67	------	5-14-62	

Wells that initially have small yields sometimes can be improved by further development. This may occur naturally as the well is used--the yield of well 27 increased 400 percent during the first year after it was drilled--or it may be accomplished by some means of well stimulation. The cost of stimulation is only a fraction of the cost of drilling a new well, and some method of stimulation should be considered before a well is abandoned because of a small yield. Acidizing is the only method of stimulation that is known by the author to have been used in the Tensleep area, and the results have not been very successful. The yield of well 28 was increased by only 10 percent and there was no appreciable change in the yield of well 7. Acidizing of limestone aquifers has been much more successful in other areas. In a report on results of well stimulation, Koenig 1/ reported that in 36 acidized wells in limestone aquifers in 15 Missouri counties the median improvement was 100 percent, 10 percent showed more than 850 percent improvement, and failures amounted to only 3 percent.

1/ Koenig, Louis, 1960, Survey and analysis of well stimulation performance: Am. Water Works Assn., v. 52, no. 3, p. 333-350.

Development of ground water apparently has not lowered artesian pressures in the area. (See table 2.) Of 8 wells for which comparative data are available, 6 have higher pressures than were measured in 1953. However, the measurements were made during a different season, and a large seasonal fluctuation of pressure may be expected in the area. Most of the wells for which data are available penetrate the Tensleep Sandstone, but changes in pressure at the well head are believed to reflect changes in artesian pressure in the area as a whole, because there probably is some movement of ground-water between formations.

Table 2.--Records of artesian pressures in wells in the Tensleep area, Wyoming, 1953 and 1962.

Well no.	Static pressure (pounds per square inch)	Pressure after well had been shut in for 5 minutes recovery (pounds per square inch)	Static pressure (pounds per square inch)	Pressure after well had been shut in for 5 minutes recovery (pounds per square inch)
	October-November 1953		May 1962	
1	100	65	---	82
10	107	---	120	---
16	28	---	32	---
31	72	---	75	---
32	25	---	---	23.5
33	6	---	[a] 7	---
34	15.7	---	10.5	---
35	62	---	67	---

[a] Measured by owner in fall of 1961.

Utilization of ground water

Ground-water use in the Tensleep area has increased substantially in the past nine years. In 1953 only well 31 flowed more than 200 gpm (gallons per minute), and the total yield of 26 wells was about 1,900 gpm. In 1962, 9 wells have yields greater than 200 gpm, 3 wells each have yields greater than the total yield of all wells in 1953, and 34 wells have a potential yield of about 14,500 gpm.

The quality of the water is good for irrigation and stock use, but the high iron content of water from some wells makes the water objectionable for domestic use. (See table 3.) Wells with high artesian pressure are especially well suited for use with sprinkler irrigation systems. A pressure of 105 pounds per square inch was measured at well 13 while a sprinkler system, which reportedly yields 1,000 gpm, was in operation, and the pressure in well 27 was so great that a pressure regulator had to be installed before a sprinkler system could be used successfully.

Table 3.--Chemical analyses of ground water in the Tensleep area, Wyoming.

Well no.	Location	Depth (feet)	Date of collection	Temperature (°F)	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids: Residue on evaporation at 180°C	Hardness as $CaCO_3$: Calcium, Magnesium	Hardness as $CaCO_3$: Noncarbonate	Per cent sodium	Specific conductance (micromhos at 25°C)	pH
1	50-90-14	2,000	11- 5-53	57	7.9	0.05	89	47	12	3.0	176	272	2.5	0.8	4.6	0.06	560	416	272	6	774	7.3
2	50-90-14ba	1,625	11- 7-53	57	8.2	1.7	59	32	8.9	1.7	199	119	2.5	.4	3.1	.05	354	278	115	7	547	7.7
7	49-89-24dc	570	11- 3-53	51	9.9	.03	80	33	7.2	2.2	259	118	5.5	.5	8.8	.05	410	337	125	4	636	7.4
8	49-89-35bb	-----	11- 2-53	--	9.1	.02	47	23	1.3	1.4	250	4.0	2.5	.2	1.7	.05	212	213	8	1	390	7.6
9	49-89-28ba	944	11- 4-53	54	9.4	.00	41	21	1.5	1.0	225	2.0	.5	.2	2.0	.02	202	188	3	2	354	7.5
10	49-89-29ab	960	11- 5-53	54	8.5	.62	51	19	1.9	1.3	224	25	2.0	.3	1.9	.02	214	207	23	2	391	7.5
15	48-88- 9bd	-----	11- 9-53	51	8.9	.25	56	24	2.0	1.4	290	2.0	2.5	.2	5.5	.03	246	240	2	2	450	7.5
19a	47-87- 6c1	-----	10-30-53	53	9.9	.01	37	17	1.8	.8	194	1.0	1.5	.0	2.4	.00	168	162	3	2	307	7.6
19b	47-87- 6c2	-----	10-30-53	53	9.5	.10	38	16	1.9	.7	197	1.0	1.5	.0	2.4	.02	172	162	0	2	308	7.5
20	47-89-12db	901	10-30-53	57	8.3	.71	49	25	2.4	2.1	256	15	2.0	.4	.5	.00	232	225	15	2	421	7.3
23	47-88-16cb	1,050	5-10-62	--	11	.04	44	28	2.9	2.0	250	17	1.0	.4	.9	.00	227	224	19	3	445	7.5
26	47-88-21bb	758	10-31-53	--	7.3	1.0	50	21	12	3.6	217	56	3.0	.6	.0	.04	266	212	34	11	444	7.7
29	46-87-21ac	912	10-31-53	58	9.6	2.3	58	28	3.0	1.4	289	24	2.0	.2	.0	.01	282	259	22	2	474	7.6
31	44-87- 8dd	1,040	11-11-53	58	8.0	.07	43	16	1.3	1.2	166	34	1.0	.6	.0	.01	188	173	37	2	329	7.5
32	44-87-17dd	-----	11-12-53	56	9.6	.03	45	21	12	1.2	192	60	2.0	.2	.3	.21	246	200	43	11	414	7.5
33	43-87-11dc	443	11-12-53	50	11	.00	43	22	1.4	1.8	228	9.0	1.0	.2	1.0	.01	202	200	13	1	365	7.5
34	43-87-20da	-----	11-12-53	--	9.4	1.1	59	27	2.6	1.0	258	44	1.0	.3	.0	.03	273	256	44	2	470	7.4

Conclusions

The potential withdrawal of ground water in 1962 was more than seven times as great as it was in 1953, but, except for two wells, there is no evidence that artesian pressures have declined in the area. Periodic measurements of a number of observation wells would provide data regarding the magnitude of seasonal fluctuations that can be expected in the area. After this has been determined, the number of observation wells and the frequency of measurements might be reduced. If future development of ground water requires further investigation in the area, these measurements would serve as a basis for the interpretation of changes in artesian pressures that might have occurred.