INFORMATION SERIES 13

Chemical Analyses of Water Wells in Selected Strippable Coal and Lignite Areas, Denver Basin, Colorado

by Robert M. Kirkham
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COLORADO GEOLOGICAL SURVEY
DEPARTMENT OF NATURAL RESOURCES
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INTRODUCTION

This report presents the results of a water well inventory and sample program in four selected areas known to contain strippable coal and lignite deposits. The investigation was conducted during the summer and fall of 1979 as part of a cooperative agreement between the Colorado Geological Survey and the U.S. Geological Survey, Water Resources Division-Colorado District and as part of U.S. Geological Survey, Geologic Division Grant No. 14-08-0001-G-487 on the Study of Environmental Impact of Energy Resource Development in the Denver Basin, Colorado. We thank both Divisions of the U.S. Geological Survey and several individuals, including J.F. Blakey, L.R. Ladwig, J.W. Warner, R.H. Pearl, and J.D. Maberry, for their cooperation which made this study possible.

Strippable coal and lignite deposits occur in the Denver and Laramie Formations over large areas in the Denver Basin, Colorado (Kirkham and Ladwig, 1979, 1980). The Upper Cretaceous Laramie Formation contains subbituminous coal and lignite in the lower 275 ft (82.5 m) of the formation. Thick lignite beds occur in the upper 500 ft (150 m) of the Upper Cretaceous-Paleocene Denver Formation. These formations also include or are stratigraphically adjacent to important bedrock aquifers (Romero, 1976).

Extensive mining of Laramie Formation coal within the Denver Basin took place during the first half of the 20th Century but during the late 1970s, the last producing mine closed. With the resurgence of coal and lignite as an energy source, there has been a noted increase in coal mining activity in the basin.

Several proposed coal strip mines are currently in the permitting state or have initiated mine construction. Additional strip mines are anticipated in the shallow parts of the basin (Kirkham and Ladwig, 1980). The deeper portions of the basin are also of interest for possible underground coal gasification, if it proves to be technologically, economically and environmentally feasible.

One of the primary environmental problems related to coal recovery in the Denver Basin is the potential effect on ground-water quality and quantity (Kirkham and Ladwig, 1980). This report presents baseline data on water quality and water levels in wells in four areas likely to experience future coal or lignite surface mining. By no means does this report contain sufficient data to fully understand the ground-water quality aspects of all strippable areas or even the four sample areas, but it does provide initial data which can be used as a base for future regional and site specific studies.

Areas in which water samples were collected include the Watkins, West Bijou Creek, Keenesburg, and Matheson areas (Figure 1). The locations of wells sampled in these areas are shown in Figure 2 for the Watkins area, in Figure 3 for the West Bijou Creek area, in Figure 4 for the Keenesburg area, and in Figure 5 for the Matheson area. All four areas contain significant strippable coal and lignite deposits.

Appendix 1 lists the characteristics of water wells sampled during this investigation. Included in this table are the well identification numbers assigned in this report and used on the location maps (Figure 2, 3, 4, and 5), well location, permit number, well owner, completion year, total depth, primary aquifer, type of lift and power, altitude, water level depth, date of water level measurement, and use of the water. All samples were analyzed for specific conductance, pH, temperature, calcium, magnesium, potassium, silica, sodium, phosphorous, chloride, fluoride, sulfate, nitrite and nitrate, iron, manganese, hardness, and alkalinity. Results of the analyses are listed in Appendix 2.

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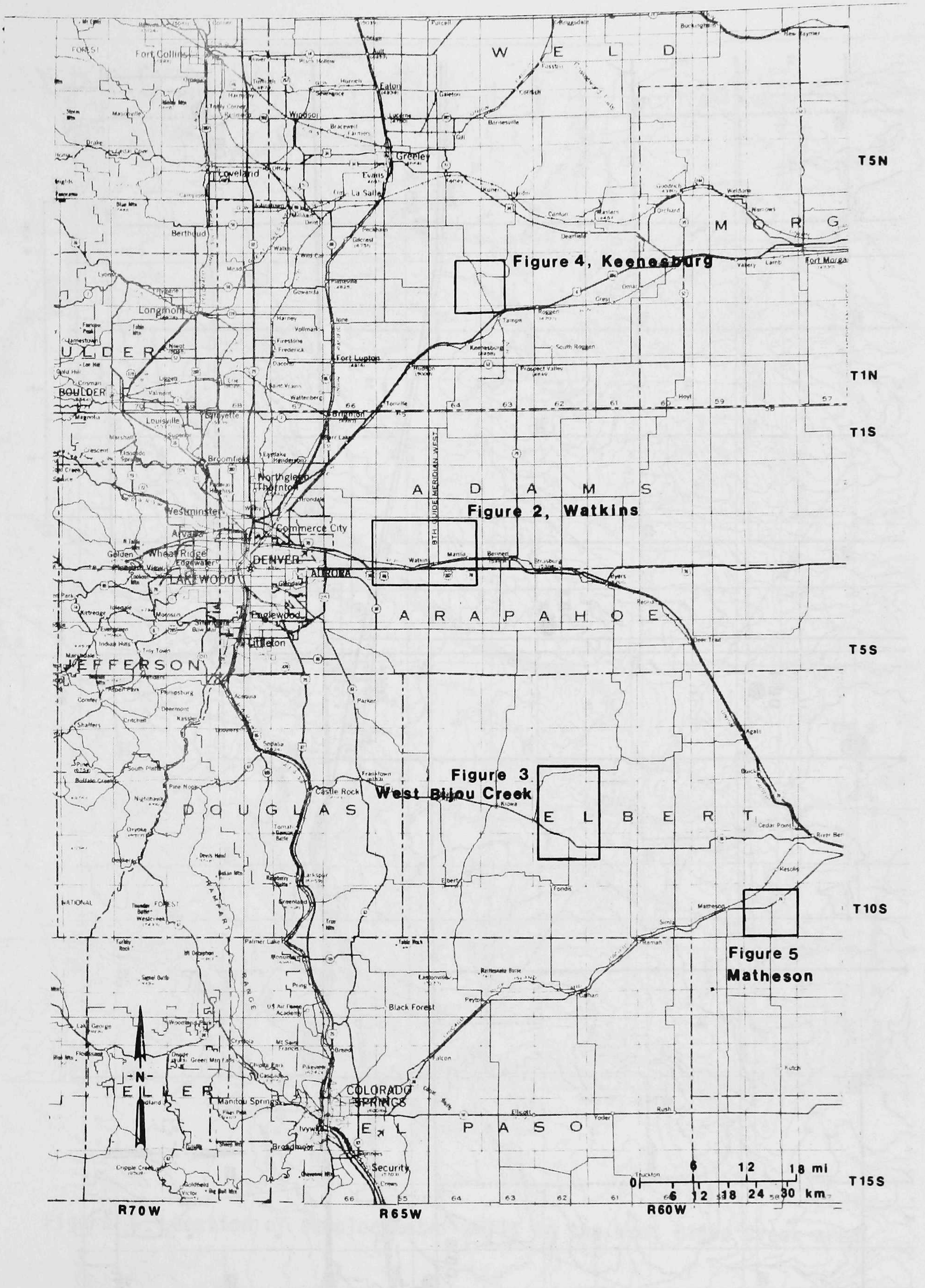

Figure 1. Index map showing sample areas.

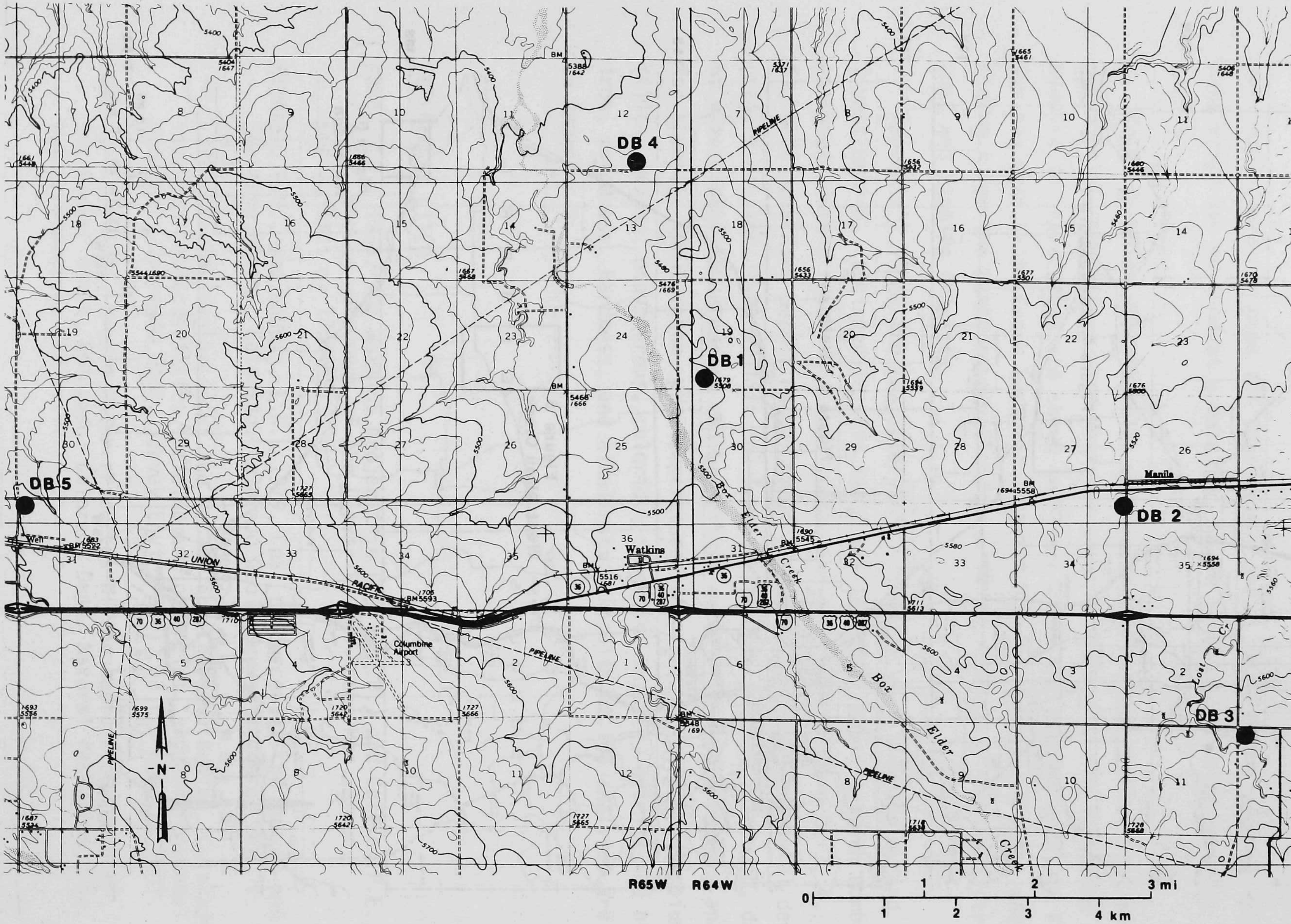

Figure 2. Location of sampled water wells in the Watkins area.

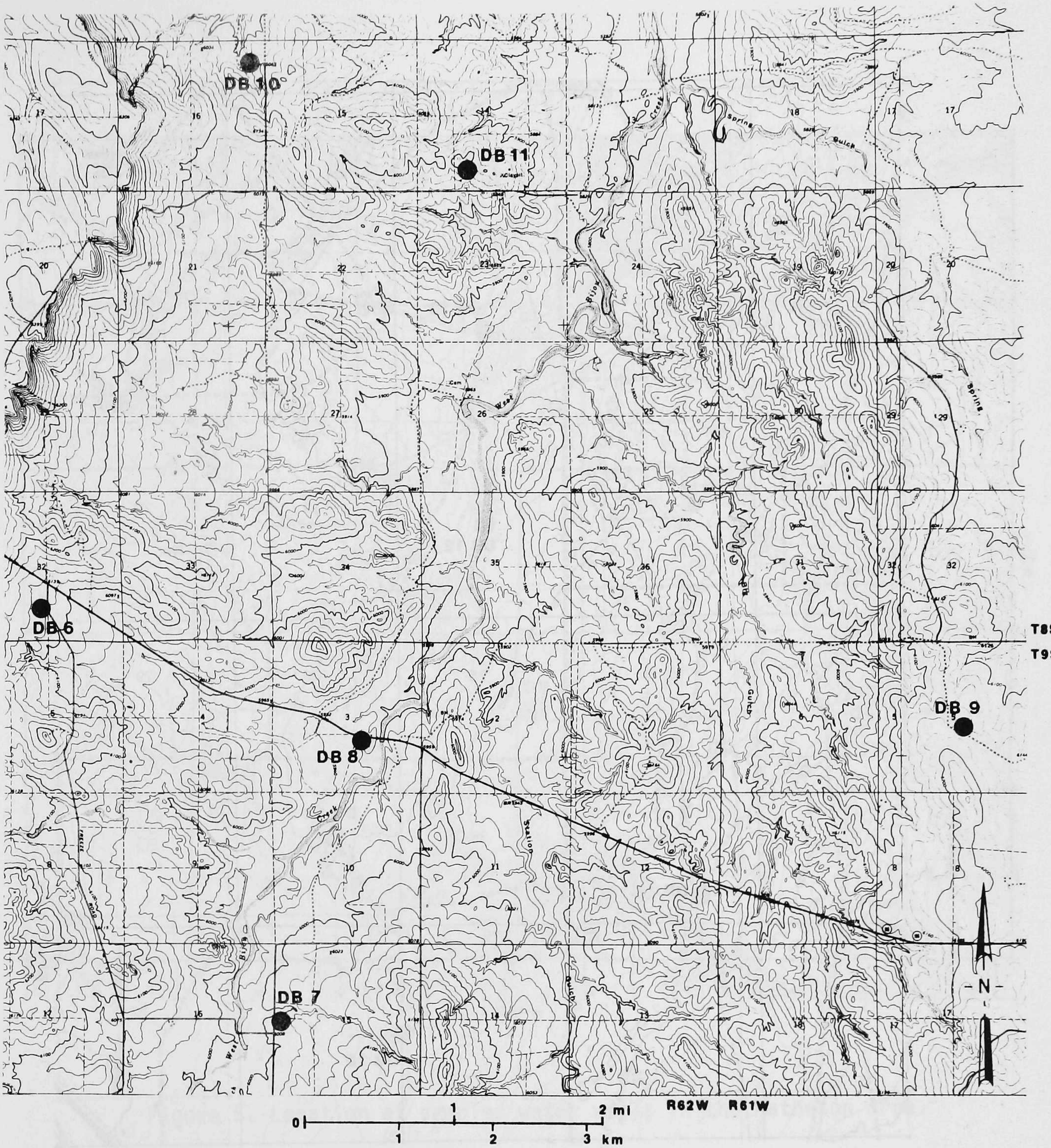

Figure 3. Location of sampled water wells in the West Bijou Creek area.

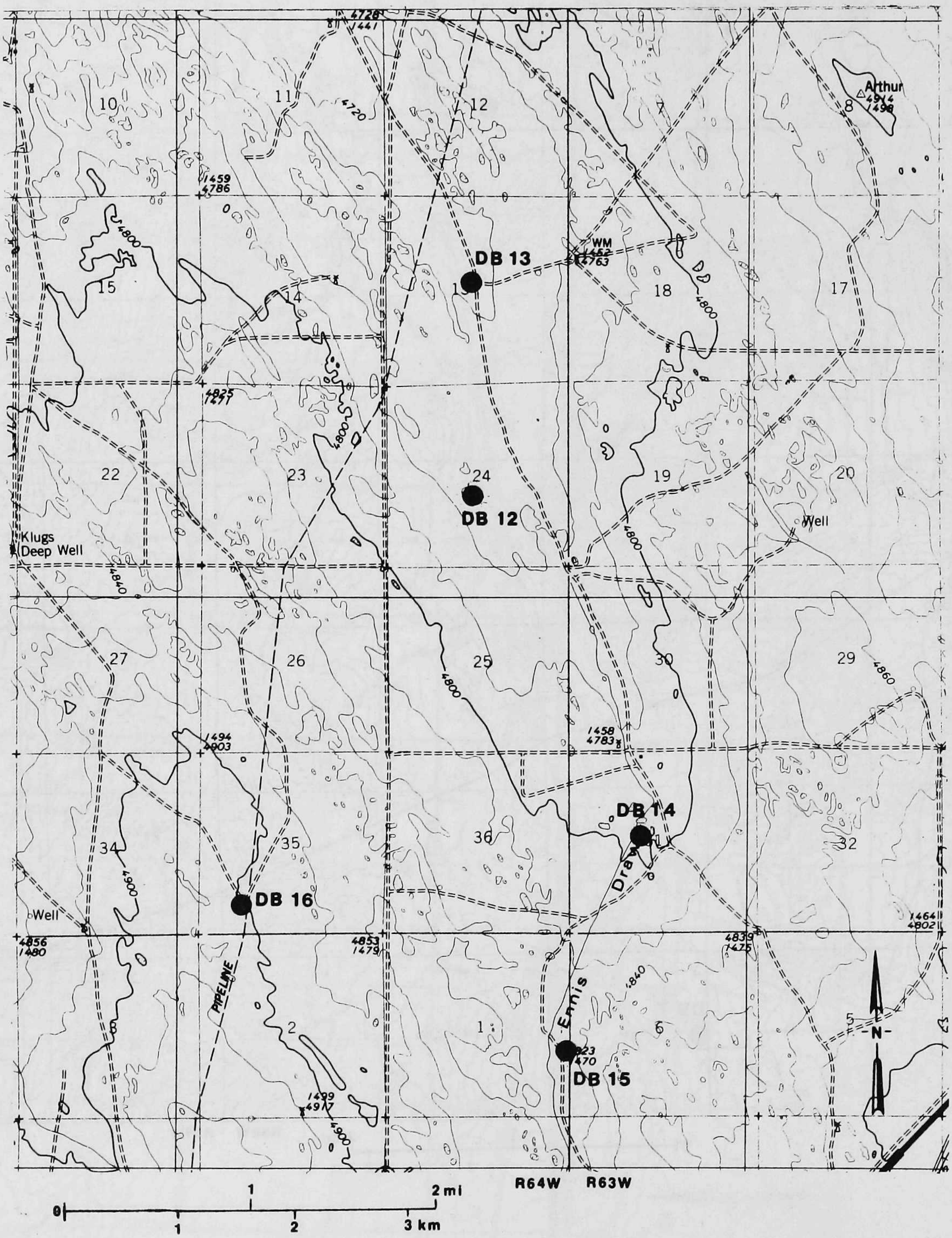

Figure 4. Location of sampled water wells in the Keenesburg area.

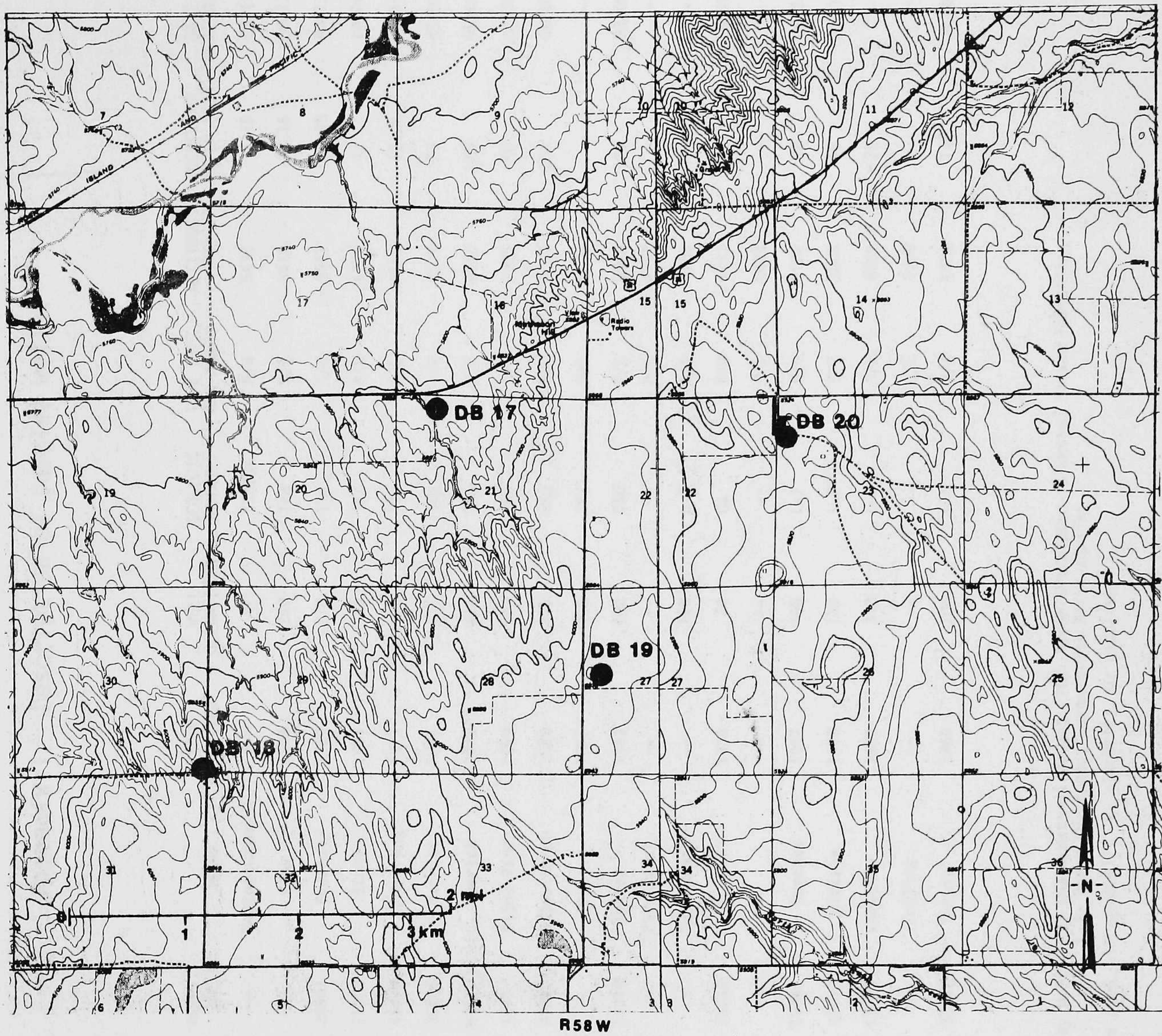

Figure 5. Location of sampled water wells in the Matheson area.

Appendix 1. Description of sampled wells.

I.D. NO.	LAND NET LOCATION	PERMIT NO.	OWNER	YEAR COMPLETED	WELL DEPTH (FT)	GEOLOGIC SOURCE[1]	TYPE LIFT AND POWER[2]	ALTITUDE (FT)	DEPTH TO WATER (FT)	DATE OF MEASUREMENT	USE OF WATER[3]
DB-1	T03S,R64W, S.19ccd	--	Horton-Cavey R.	--	47	TKd/Qa	P/W	5495	5.18	08/13/79	S
DB-2	T03S,R64W, S.34aaa	681	Frey	1958	240	TKd	S/E	5555	88.16	08/13/79	D
DB-3	T04S,R64W, S.12bbb	39941	Guernsey	1969	228	TKd	S/E	5642	74.36	08/13/79	D
DB-4	T03S,R65W, S.12dcd	21823	Stone	1964	79	TKd	P/W	5430	42	10/08/64	D
DB-5	T03S,R65W, S.31bbb	45714	Armstrong	1973	95	TKd	S/E	5502	42.05	08/15/79	D
DB-6	T08S,R62W, S.32cda	26506	Everitt	1966	138	TKd	P/W	6125	78	08/03/66	S
DB-7	T09S,R62W, S.15cbb	42622	Herrick	1970	401	TKd	S/E	6010	100	09/02/70	D
DB-8	T09S,R62W, S.03dbb	3777	Bijou Ranch	1959	125	TKd	S/E	5925	40	07/30/59	D
DB-9	T09S,R61W, S.05bdd	37278	Bijou Ranch	1969	378	TKd	S/E	6170	250	04/06/69	S
DB-10	T08S,R62W, S.16aac	--	Scott	1977	235	TKd	S/E	6020	--	--	D
DB-11	T08S,R62W, S.14cdc	14310	Tucker	1963	400	TKd	P/E	5980	180	03/00/63	D
DB-12	T03N,R64W, S.24cad	--	Farr Ranch	--	--	--	P/G	4752	--	--	S
DB-13	T03N,R64W, S.13bdd	--	Farr Ranch	--	150	L-F	S/E	4738	--	--	D
DB-14	T03N,R63W, S.31bdd	75238	Cuykendall	1936	34	Qa	P/W	4783	4.37	08/28/79	S
DB-15	T02N,R64W, S.10dad	--	--	--	--	--	P/W	4823	--	--	S
DB-16	T03N,R64W, S.35cdb	11046	2E Ranches	1962	400	L-F	P/G	4902	92	04/27/62	S
DB-17	T10S,R58W, S.21bba	43413	Dickens	1970	120	L-F	S/E	5808	46	10/00/70	S
DB-18	T10S,R58W, S.31daa	17729	Hamacher	1963	348	L-F	S/E	6055	> 70	--	D
DB-19	T10S,R58W, S.27bcc	--	Collins	--	--	--	S/E	5980	--	--	D
DB-20	T10S,R58W, S.23bbc	37542	Kochis	1969	200	L-F	S/E	5922	146	00/00/69	S

1. deepest formation tapped by well; Qa: Quaternary alluvium; TKd: Upper Cretaceous-Paleocene Denver Formation; L-F: Upper Cretaceous Laramie-Fox Hills aquifer
2. P: piston; S: submergible pump; W: windmill; E: electric; G: gasoline
3. S: stock; D: domestic

Appendix 2. Chemical analyses of water from sampled wells.

SAMPLE I.D. NUMBER	SAMPLE DATE	LAB pH	LAB SPECIFIC CONDUCTANCE (MICROMHOS)	TEMP °C	CALCIUM DISSOLVED (MG/L)	MAGNESIUM DISSOLVED (MG/L)	POTASSIUM DISSOLVED (MG/L)	SODIUM DISSOLVED (MG/L)	ALKA-LINITY (MG/L AS $CACO_3$)	CHLORIDE DISSOLVED (MG/L)	SULFATE DISSOLVED (MG/L)
DB-1	08/13/79	7.7	3124	12.5	230	95	4.4	380	230	140	1300
DB-2	08/13/79	7.9	708	15.5	27	2.7	3.7	130	260	93	7.2
DB-3	08/13/79	7.8	718	16.0	92	15	5.3	39	160	50	140
DB-4	08/13/79	7.8	861	13.0	120	22	3.1	20	200	3.5	200
DB-5	08/15/79	8.0	719	12.5	86	16	3.7	43	180	33	140
DB-6	08/20/79	7.6	1054	14.0	97	8.2	6.9	87	88	14	430
DB-7	08/20/79	8.4	715	14.5	5.6	0.6	1.6	160	240	8.6	130
DB-8	08/20/79	8.3	607	14.5	4.4	0.6	1.4	140	230	7.7	68
DB-9	08/20/79	7.7	1035	15.3	99	13	5.6	110	170	4.3	370
DB-10	08/21/79	8.0	770	14.3	62	4.6	4.4	100	190	5.9	200
DB-11	08/21/79	8.2	873	17.0	13	1.2	2.4	180	230	7.1	200
DB-12	08/28/79	7.7	4419	14.5	280	140	35	600	430	180	1700
DB-13	08/28/79	8.1	1248	18.5	3.0	0.8	2.1	300	540	110	5.7
DB-14	08/30/79	7.7	1836	17.0	160	56	21	180	250	63	580
DB-15	08/30/79	7.7	2295	14.9	160	66	9.6	340	250	200	830
DB-16	08/30/79	8.2	1237	17.0	2.9	0.7	2.2	290	540	110	11
DB-17	09/06/79	6.1	527	14.0	67	15	3.2	16	35	4.8	210
DB-18	09/06/79	7.2	264	14.5	27	5.5	3.4	18	99	2.1	29
DB-19	09/06/79	7.6	213	14.5	24	4.3	2.8	11	84	1.8	11
DB-20	09/06/79	7.6	240	13.5	24	5.0	3.0	18	100	1.4	14

FLUORIDE DISSOLVED (MG/L)	NITROGEN NO2 + NO3 DISSOLVED (MG/L AS N)	PHOSPHOROUS DISSOLVED (MG/L AS P)	SILICA DISSOLVED (MG/L)	DISSOLVED SOLIDS, TOTAL (MG/L)	HARDNESS (MG/L AS $CACO_3$)	HARDNESS NONCARB. (MG/L AS $CACO_3$)	IRON DISSOLVED (UG/L)	MANGANESE DISSOLVED (UG/L)	SAMPLE I.D. NUMBER
1.1	8.3	0.03	19	2440	1400	1200	150	10	DB-1
0.9	0.14	0.00	8.8	436	79	0	80	30	DB-2
0.6	6.3	0.07	29	495	290	130	20	3	DB-3
1.8	15	0.00	20	592	390	190	200	20	DB-4
0.5	7.2	0.03	24	486	280	100	10	3	DB-5
0.8	0.14	0.00	11	709	280	190	1000	370	DB-6
1.7	0.59	0.07	9.7	465	16	0	80	9	DB-7
1.8	0.80	0.10	9.9	376	13	0	70	10	DB-8
0.5	2.6	0.00	19	736	300	130	670	120	DB-9
2.0	0.61	0.02	8.5	504	170	0	20	30	DB-10
1.1	0.49	0.03	9.9	555	37	0	60	20	DB-11
4.7	27	0.01	17	3340	1300	850	10	300	DB-12
4.1	0.39	0.05	11	781	11	0	60	10	DB-13
2.3	35	0.01	20	1390	630	380	60	100	DB-14
2.2	3.9	0.05	25	1800	670	420	0	80	DB-15
4.1	0.15	0.01	11	769	10	0	40	6	DB-16
0.7	3.4	0.03	41	397	230	190	2300	620	DB-17
0.5	0.13	0.01	29	175	90	0	70	30	DB-18
0.4	1.7	0.07	28	141	78	0	20	2	DB-19
0.4	0.69	0.06	25	154	81	0	10	1	DB-20