STATE OF SOUTH DAKOTA
William J. Janklow, Governor

DEPARTMENT OF WATER AND NATURAL RESOURCES
Warren R. Neufeld, Secretary

GEOLOGICAL SURVEY
Duncan J. McGregor, State Geologist

Open-File Report No. 28-UR

GROUND-WATER STUDY FOR SOUTHERN UNION COUNTY

by

Derric L. Iles

Science Center
University of South Dakota
Vermillion, South Dakota

1979

CONTENTS

FIGURES

TABLE

APPENDICES

INTRODUCTION

This report contains the results of a special groundwater investigation conducted by the South Dakota Geological Survey in the portion of Union County which lies south of Elk Point. The investigation included the drilling of 60 test holes (figs. 1, 1a, and app. A), the installation of 41 observation wells (observation wells have the same numerical designation as the test holes into which they were placed) (figs. 1 and 1a, and app. A), collecting and analyzing 59 water samples (fig. 2, app. B, and table 1), taking 8 core samples from the bottom of McCook Lake (fig. 3 and app. C), and making a well inventory (app. D). Also, small scale pump tests were conducted to try to induce recharge from the Missouri and Big Sioux Rivers into the adjacent sediments.

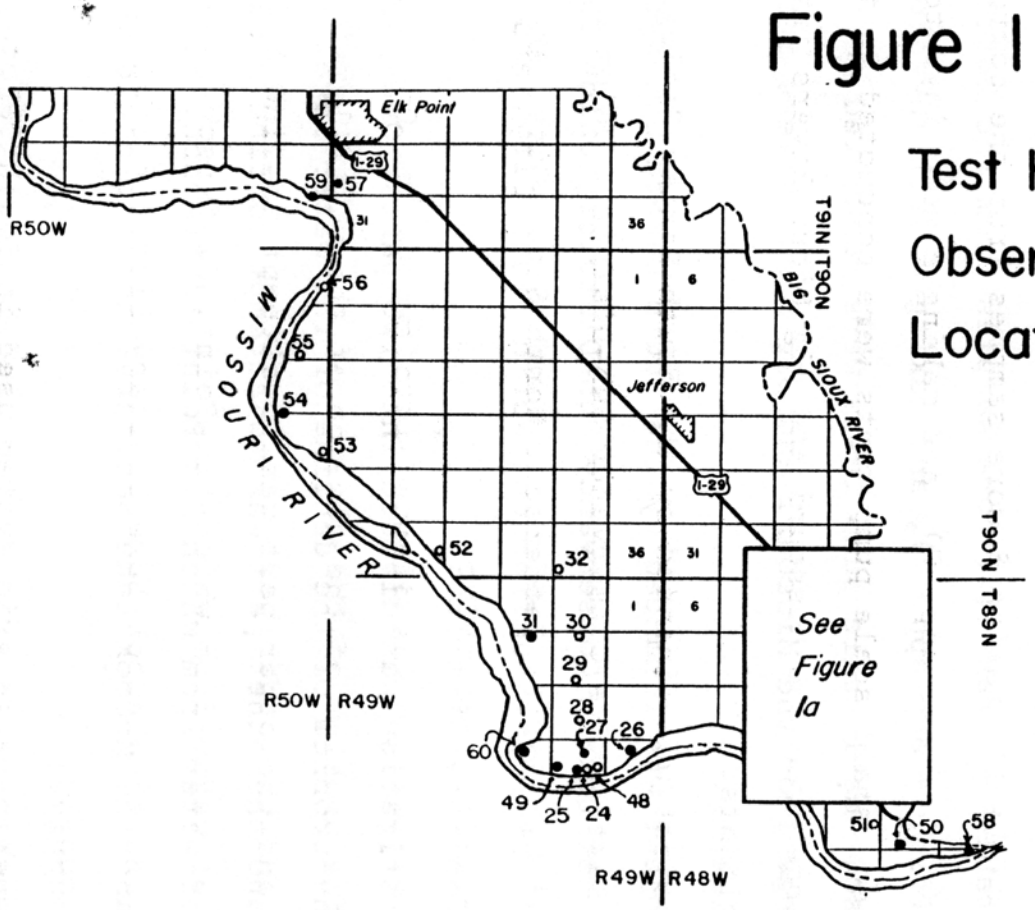
This project was financed by the South Dakota Geological Survey, the East Dakota Conservancy Sub-District, Union County, the cities of Elk Point, Jefferson, North Sioux City, and the McCook Lake Sanitary District.

The investigation was divided into two parts. One part was to analyze the problem of the decline of the water level in McCook Lake and the other part was to attempt to find a suitable source of water from which Elk Point, Jefferson, North Sioux City, and the McCook Lake Sanitary District could obtain their water supply.

The township-range grid system used in South Dakota is different from that used in Nebraska. Due to the course changes of the Missouri River that have occurred since the original

Figure 1

Test Hole and Observation Well Locations



0 1 2 3 4 5
MILES

- ○ Test hole
- ● Test hole with observation well.

N

South Dakota grid system is extended beyond the original survey (1860).

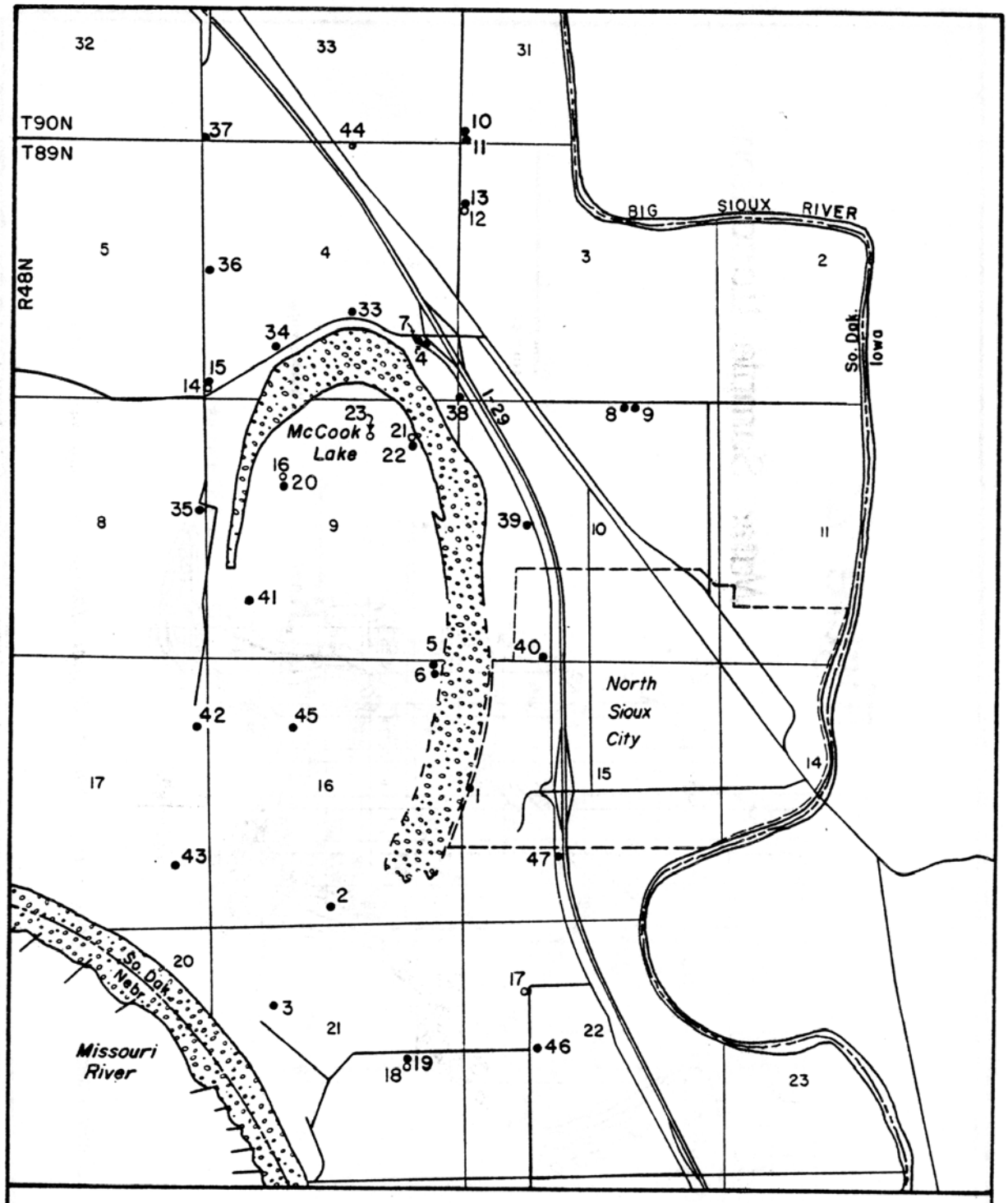


Figure 1a

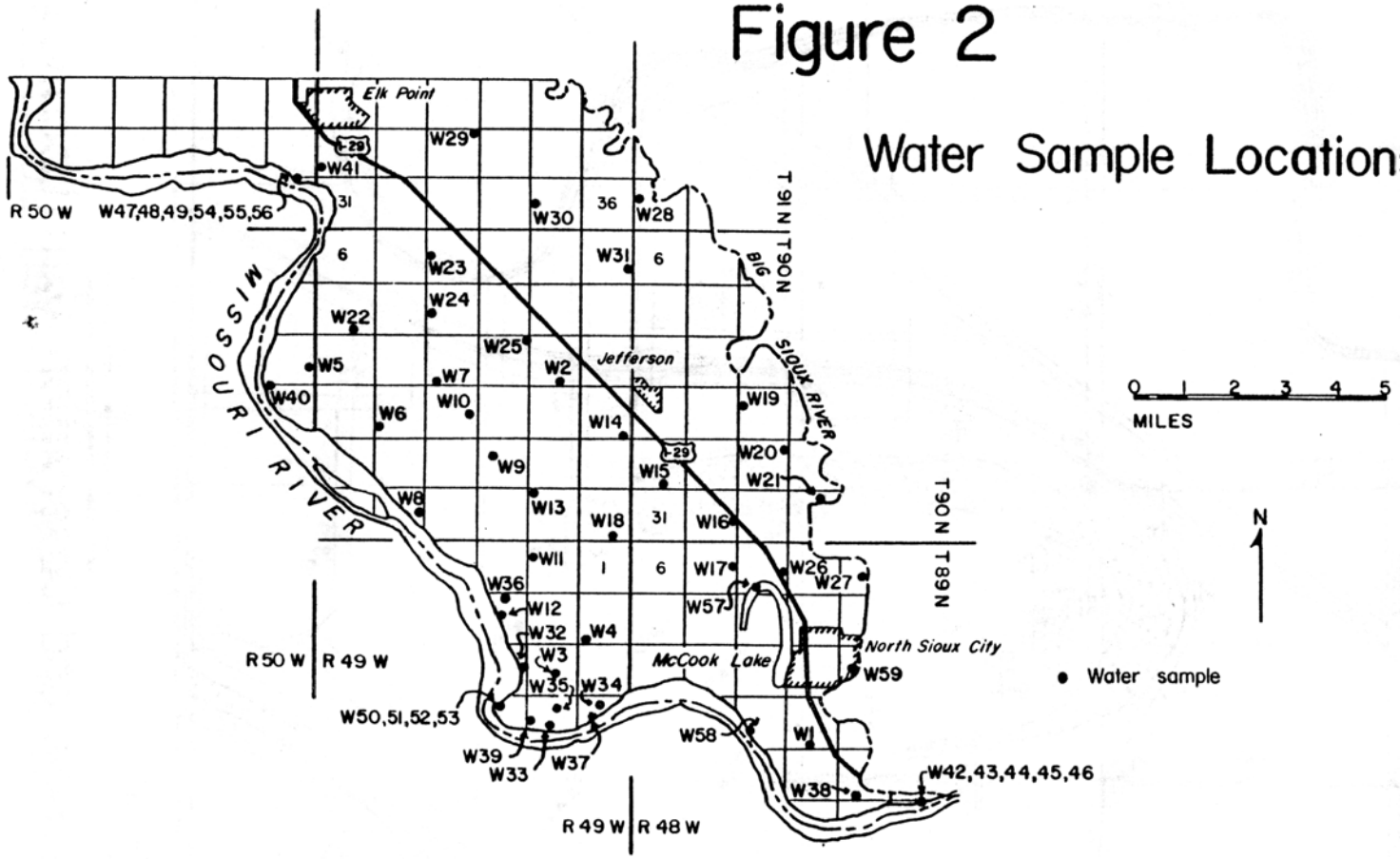
Test Hole and Observation Well Locations

○ Test hole • Test hole with observation well

South Dakota grid system is extended beyond the original survey (1860)

Figure 2

Water Sample Locations



South Dakota grid system is extended beyond the original survey (1860).

TABLE 1. Water Analyses

Sample	Source	Parts Per Million											ppb[1]
		Calcium	Sodium	Magnesium	Chloride	Sulfate	Iron	Manganese	Nitrate Nitrogen	Conductivity	Hardness $CaCO_3$	Total Solids	Selenium
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
A		------	------	-------	250[2]	250[2]	0.3[2]	0.05[2]	10.0[3]	--------	------	500[2]	10.0[3]
W 1	P	220	73	45	4	65	3.70	2.90	<0.5	1175	733	840	0.5
W 2	P	245	44	87	82	85	9.20	0.65	<0.5	1510	968	1110	0.7
W 3	P	215	91	50	10	85	6.00	3.10	<0.5	1260	741	850	0.4
W 4	P	255	75	47	16	130	6.40	0.40	<0.5	1310	828	960	0.7
W 5	P	5	415	1.2	13	200	0.40	<0.05	<0.5	1625	17	1230	0.4
W 6	P	225	70	50	9	200	10+	0.70	<0.5	1255	766	920	0.5
W 7	P	230	87	55	4	85	8.40	1.90	<0.5	1280	799	880	0.9
W 8	P	180	10	40	5	55	1.15	3.65	<0.5	785	613	560	0.2
W 9	P	220	42	47	9	130	<0.05	1.20	1.70	1075	741	770	3.8
W10	P	245	141	66	112	130	10+	1.30	<0.5	1705	881	1150	1.2
W11	P	245	51	48	18	85	10+	0.95	<0.5	1240	807	910	1.3
W12	P	240	146	57	6	30	5.20	3.70	<0.5	1540	832	1130	1.0
W13	P	200	30	33	51	<25	<0.05	1.90	2.0	905	634	670	17.0
W14	P	195	57	58	14	55	<0.05	0.33	1.1	1170	724	795	9.7
W15	P	235	101	66	9	200	4.20	6	<0.5	1535	856	1180	0.5
W16	P	160	22	55	30	40	1.60	1.05	1.1	890	624	580	2.6

Table 1 -- continued.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
W17	P	200	87	79	8	250	10+	1.53	<0.5	1705	823	1360	1.2
W18	P	160	9	33	<1	40	0.45	3.20	<0.5	730	534	500	0.2
W19	P	155	78	72	10	55	0.05	0.05	0.8	1200	682	870	5.6
W20	P	210	56	50	9	120	6.00	0.55	<0.5	1205	728	925	0.7
W21	P	215	85	53	7	100	6.80	0.86	<0.5	1315	753	970	--------
W22	P	270	40	48	39	55	0.05	0.65	33	1255	870	1010	182
W23	P	175	66	38	6	70	2.45	1.00	<0.5	1030	592	730	0.7
W24	P	160	67	44	6	85	5.40	1.66	<0.5	1025	579	725	0.2
W25	P	150	25	39	9	40	4.65	0.12	<0.5	815	534	540	0.2
W26	P	195	53	51	10	40	8	0.44	<0.5	1120	695	1090	0.7
W27	P	140	9	28	<10	35	2.50	0.10	<0.05	640	464	460	0.7
W28	P	185	51	45	15	<25	0.09	0.95	<0.5	1010	646	950	21.9
W29	P	180	58	48	<10	25	6.10	0.66	<0.5	1000	645	900	0.5
W30	P	144	42	57	10	30	0.07	0.62	10	1120	593	880	55.1
W31	P	150	58	45	<10	<25	7.90	0.82	<0.5	1010	558	970	0.9
W32	P	200	87	50	10	240	8	0.83	<0.5	1480	704	984	1.8
W33	OW25	115	72	38	17	55	9	1.35	<0.5	1000	588	704	0.2
W34	OW26	162	73	45	16.5	210	6	1.45	<0.5	1270	629	856	0.8
W35	OW27	170	90	50	13	200	7	1.28	<0.5	1330	629	900	0.2
W36	OW31	135	110	40	9	255	4.7	0.95	<0.5	1230	501	788	0.9

W37	MR	57	56	20	8	210	0.44	0.08	<0.5	610	224	364	3.0
W38	OW50	170	81	50	9	120	6.4	3.8	<0.5	1080	629	840	0.9
W39	OW49	165	95	47	18	237	6	0.85	<0.5	1340	604	948	0.5
W40	OW54	183	145	48	33	350	4.6	2.7	<0.5	1480	653	1152	1.4
W41	OW57	145	100	35	23	375	4.2	3	<0.5	1100	505	880	0.2
W42	OW58	62	65	20	7	180	<0.05	1.77	<0.5	660	237	372	0.2
W43	OW58	62	56	18	6	195	<0.05	2	<0.5	670	228	372	0.0
W44	OW58	62	61	19	12	208	0.05	1.85	<0.5	670	232	368	0.2
W45	OW58	62	60	18	11	213	0.37	1.93	<0.5	660	228	364	0.7
W46	OW58	65	57	19	7	218	1.88	2	<0.5	660	240	332	0.5
W47	OW59	70	83	19	27	253	<0.05	1.3	0.5	790	252	472	1.0
W48	OW59	72	60	21	9	253	<0.05	1.85	<0.5	730	266	448	0.3
W49	OW59	75	66	21	16	253	<0.05	1.92	<0.5	790	273	464	0.2
W50	OW60	147	85	44	17	200	<0.05	3.2	<0.5	1050	547	696	0.0
W51	OW60	152	75	46	13	200	<0.05	3.6	<0.5	980	568	736	0.5
W52	OW60	151	75	46	13	200	<0.05	3.6	<0.5	980	565	744	0.1
W53	OW60	153	76	46	13	180	<0.05	3.7	<0.5	1080	570	704	0.0
W54	OW59	62	59	15	2	255	<0.05	1.5	<0.5	720	216	432	--------
W55	OW59	65	59	16	4	260	0.1	1.95	<0.5	660	228	428	--------
W56	OW59	69	57	18	7	265	0.1	2.1	<0.5	720	246	444	--------

Table 1 -- continued.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
W57	ML	46	61	28	10	230	<0.05	<0.05	<0.5	710	230	510	--------
W58	MR	72	25	43	36	210	<0.05	<0.05	<0.5	780	356	520	--------
W59	BSR	63	64	23	8	260	<0.05	<0.05	<0.5	760	251	550	--------

[1]ppb = parts per billion

Sample A:

[2] Proposed national secondary drinking water regulations, March 31, 1977 (recommended limits)

[3]National interim primary drinking water regulations, December 24, 1975 (enforceable limits)

Source: P = private well; OW25 = observation well number 25; MR = Missouri River;
ML = McCook Lake; BSR = Big Sioux River

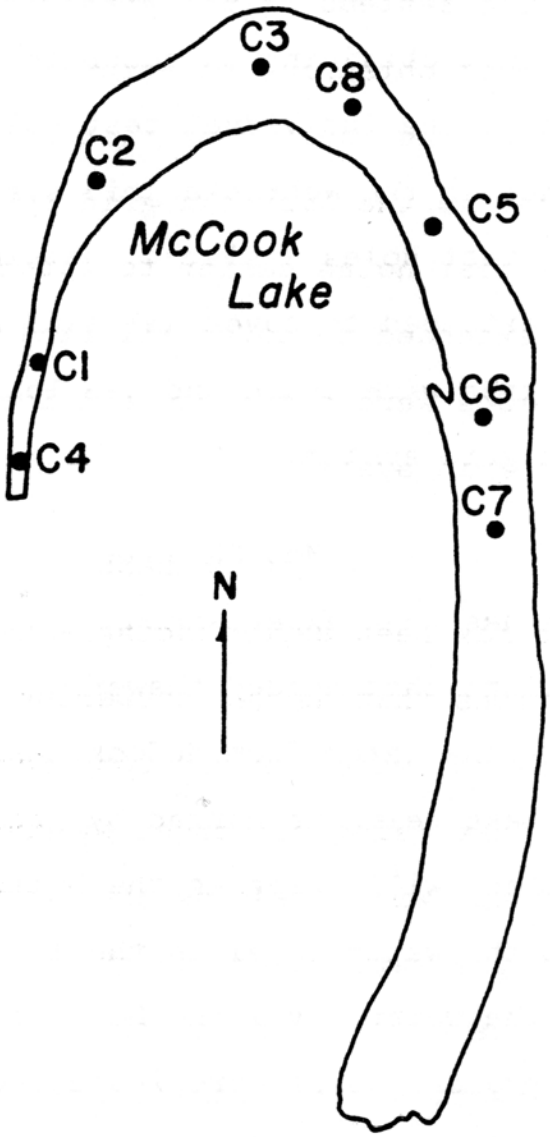


Figure 3

Core Sample Locations

1 Mile

● Core locations

survey of the area, which was made in 1860, part of South Dakota is now included in the Nebraska grid system. The boundary between the two systems is not presented clearly enough on any map to permit obtaining an accurate township-range-section location of the individual test holes drilled within the area contained in the Nebraska grid system. To make the locations of the test holes easier to obtain, the South Dakota grid system was extended to cover all land north of the Missouri River. All maps were drawn and all locations are based on the South Dakota grid system.

McCOOK LAKE

McCook Lake has been experiencing a decline in water level. The questions that needed answering were:

(1) Where is the water from McCook Lake going?

(2) Is the lake being recharged by ground water?

(3) What effect will dredging the bottom of the lake have on the water level in the lake? and,

(4) Why is the water level in the lake declining?

Thirty observation wells were installed in the immediate McCook Lake area (fig. 1a) to determine the direction of ground-water movement. The water levels in these 30 observation wells were measured seven times from May 16, 1978, to August 11, 1978 (app. E). These measurements were used to make water table contour maps (app. F). There was no water table contour map made using the 6-6-78 observation well measurements due to the lack of exact water levels for McCook Lake, the Missouri River,

and the Big Sioux River on that date. From these contour maps it can be seen that the lake is being recharged from the north and east and that it is discharging to the west and south. Water discharging from the lake enters the ground-water system and migrates in a southerly and/or southeasterly direction and eventually discharges into the Missouri or the Big Sioux River.

Eight core samples were taken from the bottom of McCook Lake (fig. 3 and app. C). These cores were taken to determine the thickness of silt on the lake bottom. Where present, the silt will act as an aquitard to ground-water movement which means the loss of water through the bottom of the lake into the ground-water system should be the slowest where the thickest accumulation of silt occurs. Varying thicknesses of silt were found at the different core sample locations with the greatest thickness observed being 166+ inches in core number 8. There was no silt layer present at all in core number 1.

If there had been a thick layer of silt throughout the entire bottom of the lake, then the possibility would have existed that the lake level was not in equilibrium with the ground-water table. If the case had existed where the lake level was higher than the ground-water table, then upon dredging and penetrating through the silt into the underlying sand, the lake level would have lowered until equilibrium with the surrounding ground-water table was reached. From the eight cores that were taken, the observation well measurements, and the water quality of the lake, it is seen that the lake is in equilibrium with the ground-water table. Also, a high concen-

tration of dissolved solids would have been noted in the lake water had the lake been "sealed off" from the ground-water system. Instead, it was noted that the lake water was comparable to the Missouri River water (table 1, samples W57, W58, and W37) apparently due to the pumping of Missouri River water into the lake and the flushing of lake water into the ground-water system.

Between May 16, 1978, and August 14, 1978, 1671.53 acre feet of water was pumped into McCook Lake by the McCook Lake Improvement Association in an attempt to raise the water level. During that period of time, there was 0.80 feet of precipitation and 1.57 feet of evaporation resulting in a deficit of 0.77 feet. On May 16 the elevation of the water in the lake was 1089.32 feet and on August 14 it was 1090.36 feet. If no water had been pumped into the lake and no recharge from the ground-water system had occurred, the lake level would have dropped 0.77 feet to an elevation of 1088.55 feet (fig. 4). In reality if there had been no pumping, the lake level would not have dropped this far because there would have been recharge from the ground-water system.

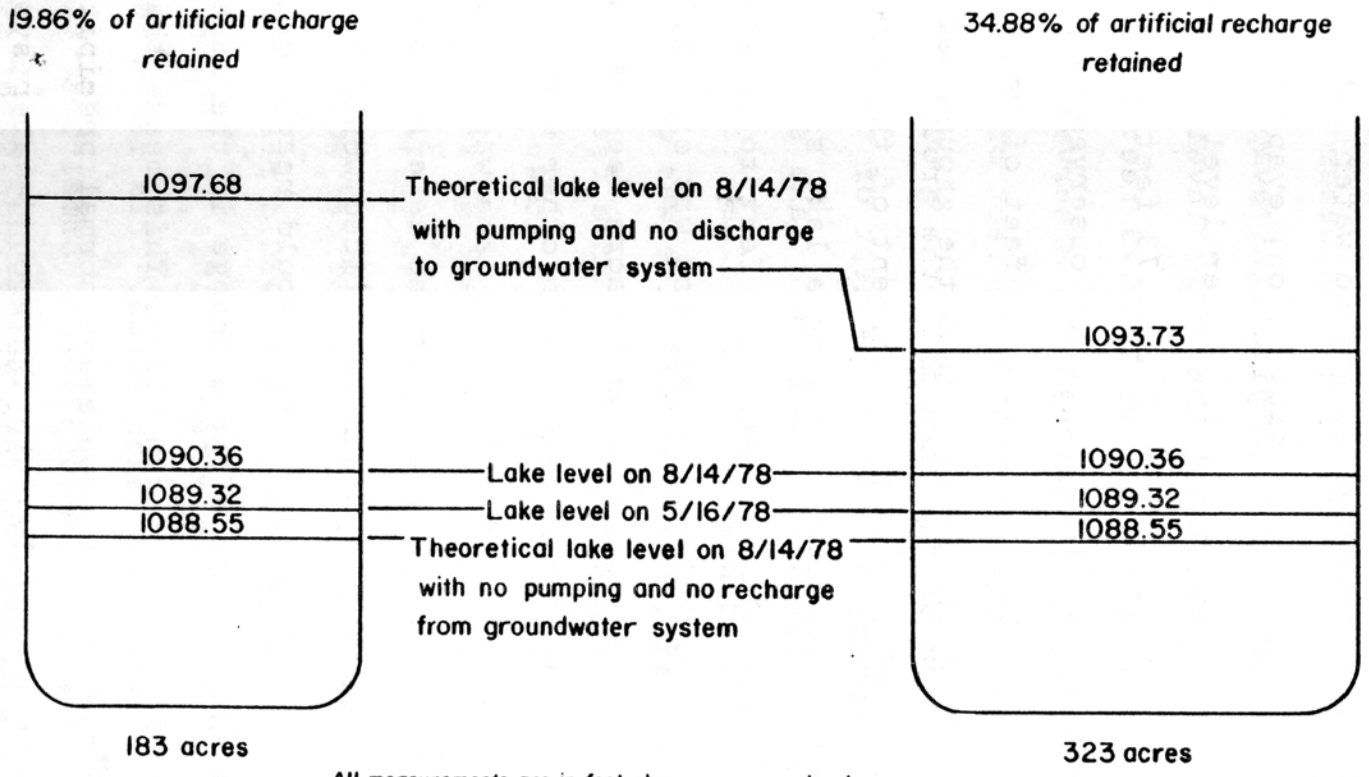
The exact size, in acres, of McCook Lake is not known at the time of this report because there was no map available showing the present size of the lake. According to a 7.5 minute series topographic map published by the United States Department of the Interior, Geological Survey, in 1963, the size of McCook Lake was larger then than it is now. The lake size shown on that map is approximately 323 acres. The

FIGURE 4

Components of Inflow and Outflow of McCook Lake

Precipitation (5/16/78 to 8/14/78) = 0.80'
Lake evaporation (5/16/78 to 8/14/78) = 1.57'
→ Net loss = 0.77 feet

Artificial recharge (pumping) = 1671.53 acre feet



All measurements are in feet above mean sea level.

approximate size of the lake at present is 183 acres. This smaller size was determined by comparing the present shoreline with the one shown on the 1963 map. Assuming a lake size of 323 acres, no discharge of lake water into the ground-water system, no recharge of ground water into the lake, and taking into account the precipitation, evaporation, and pumping of water into the lake, the water level should have risen 4.41 feet to an elevation of 1093.73 feet between May 16, 1978, and August 14, 1978. Instead the observed rise was only 1.04 feet. This means that 1088.51 acre feet of water was lost through the bottom of the lake into the ground-water system or, in other words, only 34.88 percent of the water pumped into the lake was retained. Assuming a lake size of 183 acres, the lake level should have risen 8.36 feet to an elevation of 1097.68 feet. Again, the observed rise was only 1.04 feet. In this case, it means that 1339.56 acre feet of water was lost through the bottom of the lake or, in other words, only 19.86 percent of the water pumped into the lake was retained (fig. 4).

It is thought that if the lake bottom was dredged the only effect that would be noticed would be that the lake level and the ground-water level would reach equilibrium more rapidly than they do now after a change in the lake level or ground-water level has taken place. This means that any water pumped into the lake to supplement normal precipitation would be lost more rapidly into the ground-water system.

The decline of the water level in McCook Lake is due to the down-cutting or bed degradation of the Missouri River.

The bed degradation has been accelerated by the increased erosion caused by water releases from Gavin's Point Dam and the stabilization of the river banks.

With the banks of a river made resistant to erosion by bank stabilization most of the erosive energy of the river is spent on the river bottom. Any river has a certain amount of energy capable of moving a certain amount of sediment. Both the river banks and bottom serve as a source for the sediment but if the river banks are taken away as a source by bank stabilization, then the river bottom becomes the sole source for sediment. In this case, the river will erode the bottom more vigorously in order that the energy of the river and the amount of sediment carried by it approach equilibrium conditions. Conversely, if the river bottom was made resistant to erosion the river would migrate laterally more rapidly than normal.

The presence of the dam increases erosion by the river downstream by reducing the sediment load in the water released. As water enters the reservoir created by the dam its velocity decreases which allows sediment to settle out of the water. After the relatively sediment free water leaves the reservoir, it erodes in order that river energy and sediment load can begin to approach equilibrium. Considering all other factors equal, the less sediment a river contains the more capable it is of eroding.

Also, because the reservoir behind Gavin's Point Dam is able to accommodate the seasonal increases in runoff there

is not the usual flooding which is associated with uncontrolled rivers. This has two obvious impacts on the downstream environment. There is not any recharge to the floodplain aquifer by flood waters passing over it and there is no addition of silt deposits that are associated with flooding. The recharge of the aquifer by the flood waters would have been a short term situation wherein water levels would have most likely declined rapidly to pre-flood levels, thus having little overall effect on the level of McCook Lake. The deposition of silt by the flood waters, however, would have decreased the lake depth and increased the rate at which a marsh type environment became dominant in McCook Lake.

The degree to which bed degradation has been increased by bank stabilization and Gavin's Point Dam and the degree to which silt deposition has been reduced by Gavin's Point Dam cannot be determined with the information at hand. It is certain, though, that even without man-made modifications to the river environment, there would have been bed degradation in the Missouri River.

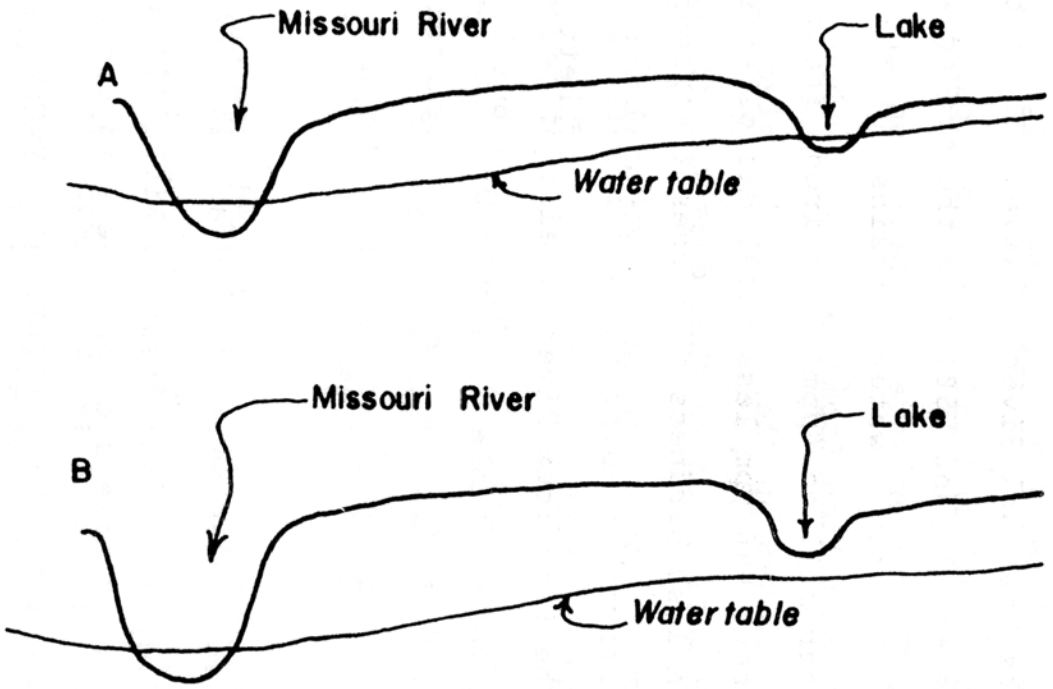
The Missouri River is, generally speaking, the lowest level of the water table. When bed degradation occurs, the river and water table levels are lowered accordingly and consequently so is the lake level. This relationship is illustrated in Figure 5.

WATER SUPPLY

Water samples were taken from 32 private wells scattered

Figure 5

Sketch showing the effect of bed degradation on the water table.



enk

throughout southern Union County (fig. 2, app. B, and table 1). Thirty of these samples exceeded the recommended limit for manganese and 25 exceeded the recommended limit for iron. Two samples exceeded the recommended limit for nitrate but this is not an area-wide problem. However, the water analyses show that high concentrations of iron, manganese, and hardness in the water is a problem common to all of southern Union County.

The Missouri River, however, is of better quality (table 1, samples W37 and W58) than the ground water in southern Union County. The river water contains, on the average, about 4.3 parts per million (ppm) less iron, about 1.3 ppm less manganese, about 446 ppm less total dissolved solids, and about 396 ppm less hardness than does the ground water. These numbers were arrived at using the water analyses in this report.

The Big Sioux River is also of better quality than the ground water (table 1, sample W59) but because of the variability in stream flow and the associated variablity in chemical quality it was not considered as a viable source of water.

Test holes were drilled and some observation wells were installed along the Missouri River (figs. 1 and 1a) to determine if permeable sediments were in contact with the river and to find out to what extent the river water was affecting the quality of the nearby ground water. The results show that there are permeable sediments all along the river and that the river has not substantially affected the ground-water quality because most of the time the ground-water gradient is towards

the river except when discharge from Gavin's Point Dam is increased to a point where the river is at a higher level than the ground-water table.

Three 4-inch diamter wells were installed at different points along the Missouri River (fig. 1, test holes 58, 59 and 60) and pumped with air for a few hours, with water samples being taken at regular intervals, to try to induce recharge from the river into the ground adjacent to the river. Observation well number 58 was pumped for 4 hours during which time the iron content increased from <0.05 ppm to 1.88 ppm and the manganese content increased from 1.77 ppm to 2 ppm (table 1, samples W42, W43, W44, W45 and W46). Observation well number 59 was pumped for 2 hours during which time the iron content remained at <0.05 ppm but the manganese content rose from 1.3 ppm to 1.92 ppm (table 1, samples W47, W48 and W49). Observation well number 60 was pumped for 3 hours during which time the iron content remained at <0.05 ppm and the manganese content increased from 3.2 ppm to 3.7 ppm (table 1, samples W50, W51, W52, and W53).

It is believed that the method used to pump these three observation wells did not pump water at a high enough rate and/or the duration of the pumping was not long enough to induce the desired recharge from the Missouri River into the adjacent ground. Of these three wells, number 59 had the best quality water in terms of iron and manganese. As a consequence this well was pumped again but for a longer time. The second time it was pumped for 6 hours during which time the iron

content increased from <0.05 ppm to 0.1 ppm and the manganese content increased from 1.5 ppm to 2.1 ppm (table 1, samples W54, W55 and W56). At the end of 6 hours the drawdown in the well was 0.51 feet. Again, the desired recharge from the river was not achieved as is shown by the high manganese content.

A temporary observation well was installed at the confluence of the Big Sioux and Missouri Rivers along the shore of the Big Sioux. The well was 10 feet deep and was pumped once for 3 hours and again, at a later date, for 7 hours at approximately 10 gallons per minute. During the 3-hour interval the iron and manganese content rose from initial values of 0.53 ppm and 0.97 ppm to 1.6 ppm and 1.8 ppm, respectively. At the beginning of the 7-hour interval the iron and manganese values were 1.0 ppm and 3.2 ppm, respectively. After 7 hours of pumping the iron and manganese values were 2.4 ppm and 1.8 ppm, respectively. During this second interval of pumping the values show a decrease in manganese content rather than an increase. This trend of a decrease in manganese content is opposite that observed the first time this well was pumped and is opposite that observed in any other observation well. The reason for this change in trend is not known.

At this site, a sample of sand into which the well was placed and a sample of mud from the bottom of the Big Sioux River were taken. These two samples were then checked as possible sources for iron and manganese. Each sample was mixed with Vermillion city water which had <0.05 ppm iron and <0.05 ppm manganese. After 23 hours of continuous mixing the water

mixed with the sand sample increased in iron content to 0.25 ppm while the manganese content remained the same. After 30 hours of continuous mixing the water mixed with the mud sample increased in iron content to 0.06 ppm and increased in manganese content to 3.6 ppm. The sand, then, appears to be a source of iron and the mud appears to be a source of manganese.

Near the site of observation well 59 a temporary horizontal well was installed at a depth of 3 feet below the river level and immediately adjacent to the river. After pumping the well with air for 7 hours both the iron and manganese contents remained low; 0.03 ppm iron and 0.05 ppm manganese. This horizontal well was the only observation well which yielded water with low amounts of both iron and manganese. This was due to the almost immediate recharge of the sand surrounding the well by the Missouri River.

It is possible to induce recharge from the Missouri River with a properly designed and placed well pumping at a high enough rate. The amount of water needed to be pumped from a well to achieve this recharge will increase with the depth of the well and the distance from the river. Therefore, the shallower the well and the closer it is to the river, the easier it will be to achieve the recharge.

RECOMMENDATIONS

It is recommended that a test site be chosen along the Missouri River and two pump tests be conducted. The difference between the two tests should be that the production well should

be vertical in one test and horizontal in the other. Frequent tests on water quality will show how long it takes at the particular pumping rate for the induced recharge to reach the well. These tests will help to design proper wells that could yield water indirectly from the river.

Before permanent wells are drilled, the proper officials should contact the Office of Water Rights, Department of Water and Natural Resources, to obtain water rights and a permit to drill the wells, and the Office of Water Quality, Department of Water and Natural Resources, to determine the biological and chemical suitability of the water.

APPENDIX A

TEST HOLE LOGS
(for map locations, see figs. 1 and 1a)

All elevations have been estimated using a 7½ minute topographic map and are presented in feet above mean sea level.

Observation wells have the same numerical designation as the test holes into which they were placed.

Test Hole 1
Location: SW¼SW¼SW¼NW¼ sec. 15, T. 89 N., R. 48 W.
Date Drilled: August 11, 1977
Elevation: 1095

0- 15	Silt, brown, clayey, sandy, fine
15- 41	Silt, brown to gray, some coal, sandy, medium to fine
41- 54	Silt, black, compact, greasy, sandy
54- 61	Gravel, medium, subrounded
61- 69	Silt, brown, and sand, fine
69- 77	Gravel, medium, angular to subrounded
77- 98	Till, black, clayey, sand, medium
98-107	Gravel, medium, subangular to subrounded, some till
107-114	Mudstone?, brown
114-135	Gravel, fine to medium
135	?, soft, not gravel or sand

* * * *

Test Hole 2
Location: SE¼SE¼SE¼SW¼ sec. 16, T. 89 N., R. 48 W.
Date Drilled: August 12, 1977
Elevation: 1094

0- 2	Topsoil, black
2- 14	Sand, light-brown, fine to very fine, clean
14- 28	Sand, light-gray, fine, rounded, clean
28- 32	Interbedded silt, light-gray, and sand, fine, rounded
32- 52	Silt, light-gray, clayey
52- 53	Lignite, black, hard
53- 62	Silt, light-gray, clayey, sandy, fine
62- 64	Lignite, black, hard
64- 94	Gravel, medium to coarse, subrounded to subangular
94-110	Silt, gray, clayey

Test Hole 2 -- continued.

110-120	Gravel, medium, subrounded to subangular
120	Hard layer, like slate or shale, impossible to drill through, abandoned hole

Observation well: 100 feet of casing; slotted from 62 feet to 94 feet

* * * *

Test Hole 3
Location: NE¼NE¼SW¼NW¼ sec. 21, T. 89 N., R. 48 W.
Date Drilled: August 12, 1977
Elevation: 1098

0- 2	Topsoil, black
2- 9	Sand, fine, rounded
9- 11	Silt, brown, clayey
11- 17	Silt, gray, compact
17- 34	Sand, fine, rounded
34- 36	Sand, fine with some coarse, some coal
36- 72	Silt, gray, compact, some sand, medium
72- 99	Gravel, medium to fine, much sand, fine to medium
99-114	Silt, gray, some coal, sand, fine
114-134	Gravel, fine to medium, subrounded to rounded

Observation well: 100 feet to casing; slotted from 72 feet to 99 feet

* * * *

Test Hole 4
Location: NE¼NW¼SE¼SE¼ sec. 4, T. 89 N., R. 48 W.
Date Drilled: August 15, 1977
Elevation: 1109

0- 2	Topsoil, black
2- 12	Silt, light-brown grading to light-gray, clayey
12- 14	Sand, light-brown, fine to very fine, silty, clayey
14- 20	Clay interbedded with silt, dark-brown to gray
20- 44	Clay, gray, soft
44- 71	Silt to clay, gray, interbedded with sand, fine to medium, rounded
71- 73	Gravel, fine to medium, subrounded to subangular
73- 74	Lignite, black, hard
74-128	Gravel, medium to coarse, subrounded to subangular
128-150	Till, light-brown, oxidized??, gravelly

Observation well: 120 feet of casing; slotted from 71 feet to 120 feet

* * * *

Test Hole 5
Location: NW¼NE¼NE¼NE¼ sec. 16, T. 89 N., R. 48 W.
Date Drilled: August 17, 1977
Elevation: 1094

0- 1	Topsoil, brown
1- 6	Sand, red-brown, fine to very fine, rounded
6- 27	Sand, gray, fine to very fine
27- 55	Silt to very fine sand, gray, clayey
55- 63	Gravel, fine to medium, rounded to subrounded
63- 70	Silt, gray, clayey
70-127	Lignite, black, hard, some gravel, medium, rounded to subrounded, intermittent layering or intermixed
127-150	Clay, gray, unoxidized

Observation well: 130 feet of casing; slotted from 70 feet to 127 feet

* * * *

Test Hole 6
Location: NW¼NE¼NE¼NE¼ sec. 16, T. 89 N., R. 48 W.
Date Drilled: August 17, 1977
Elevation: 1094

0- 1	Topsoil, black
1- 6	Sand, fine, some silt, brown
6- 17	Silt, gray, much sand, fine
17- 37	Silt, gray, clayey with sand, fine
37- 60	Silt, gray, very clayey

Observation well: 60 feet of casing; slotted from 3 feet to 60 feet

* * * *

Test Hole 7
Location: NE¼NW¼SE¼SE¼ sec. 4, T. 89 N., R. 48 W.
Date Drilled: August 17, 1977
Elevation: 1108

0- 3	Silt, dark-brown, very compact and clayey
3- 14	Silt, light-brown, compact, clayey
14- 35	Silt, light-brown, very soft, clayey
35- 50	Clay, gray

Observation well: 50 feet of casing; slotted from 5 feet to 50 feet

* * * *

Test Hole 8
Location: NW¼NE¼NW¼NE¼ sec. 10, T. 89 N., R. 48 W.
Date Drilled: August 19, 1977
Elevation: 1106

0- 35	Silt, brown, very clayey
35- 43	Clay, gray to brown, very soft
43- 66	Clay, gray, compact
66- 71	Clay, gray, compact, some sand, medium to fine
71- 79	Gravel, fine to coarse, and sand, coarse to fine, some coal
79- 95	Clay, light-brown, some sand, medium
95-103	Coal, clay, gray, some sand, medium
103-144	Gravel, fine to medium, with silt, gray, clayey, in intermittent 1-foot layers
144-160	Bedrock?, hard

Observation well: 140 feet of casing; slotted from 113 feet to 138 feet

* * * *

Test Hole 9
Location: NW¼NE¼NW¼NE¼ sec. 10, T. 89 N., R. 48 W.
Date Drilled: August 22, 1977
Elevation: 1106

0- 34	Silt, brown, clayey, soft
34- 42	Clay, gray to brown, very soft
42- 63	Clay, gray, compact
63- 72	Clay, gray, compact, some sand, medium
72- 75	Gravel, fine to coarse, and sand, coarse to fine

Observation well: bottom of well at 75 feet; slotted from 67 feet to 70 feet - sandpoint from 70 feet to 75 feet

* * * *

Test Hole 10
Location: SW¼SW¼SW¼SW¼ sec. 34, T. 90 N., R. 48 W.
Date Drilled: August 22, 1977
Elevation: 1105

0- 1	Topsoil, dark-gray, silty
1- 45	Clay, light-gray, silty
45- 64	Clay, gray, silty
64- 71	Gravel, fine to medium, some coal
71- 85	Clay, gray, silty, pebbly
85-140	Gravel, fine to medium, some coal
140-144	Gravel, coarse

Test Hole 10 -- continued.

144-148	Silt, gray
148-155	Sandstone, yellow to gray
155-157	Sandstone, yellow, fine

Observation well: 140 feet of casing; slotted from 90 feet to 140 feet

* * * *

Test Hole 11
Location: SW¼SW¼SW¼SW¼ sec. 34, T. 90 N., R. 48 W.
Date Drilled: August 23, 1977
Elevation: 1105

0- 3	Topsoil, black, clayey
3- 42	Silt, brown, clayey
42- 61	Silt, black to gray, clayey
61- 65	Gravel, medium, subrounded

Observation well: bottom of well at 65 feet; sandpoint from 60 feet to 65 feet

* * * *

Test Hole 12
Location: SW¼SW¼NW¼NW¼ sec. 3, T. 89 N., R. 48 W
Date Drilled: August 23, 1977
Elevation: 1104

0- 45	Silt, gray to brown, clayey
45- 65	Silt, gray, clayey
65-102	Gravel, medium, subrounded
102-112	Silt, gray, clayey
112-115	Gravel, medium to coarse

* * * *

Test Hole 13
Location: SW¼SW¼NW¼NW¼ sec. 3, T. 89 N., R. 48 W.
Date Drilled: August 23, 1977
Elevation: 1105

0- 1	Topsoil, gray, silty
1- 42	Clay, light-gray, partially oxidized, silty
42- 66	Clay, gray, silty
66- 95	Gravel, fine to medium, some coal
95- 97	Silt, gray

Observation well: 95 feet of casing; slotted from 75 feet to 85 feet

* * * *

Test Hole 14
Location: SW¼SW¼SW¼SW¼ sec. 4, T. 89 N., R. 48 W.
Date Drilled: August 24, 1977
Elevation: 1107

0- 2	Topsoil
2- 14	Silt, brown, clayey
14- 21	Sand, dark-brown, fine to medium, subrounded
21- 38	Silt, light-brown, clayey
38- 58	Sand, fine with some coarse, subrounded, a small amount of fine gravel
58- 65	Silt, gray to brown, clayey, some sand
65- 93	Sand, fine to medium, some fine gravel
93- 95	Gravel, lost circulation, abandoned hole

* * * *

Test Hole 15
Location: SW¼SW¼SW¼SW¼ sec. 4, T. 89 N., R. 48 W.
Date Drilled: August 24, 1977
Elevation: 1107

0- 2	Topsoil, black
2- 13	Silt, brown, clayey
13- 21	Sand, dark-brown, fine to medium
21- 38	Silt, brown, clayey
38- 55	Sand, fine to coarse

Observation well: 55 feet of casing; slotted from 18 feet to 20 feet and from 45 feet to 55 feet

* * * *

Test Hole 16
Location: SE¼NW¼SE¼NW¼ sec. 9, T. 89 N., R. 48 W.
Date Drilled: August 24, 1977
Elevation: 1093

0- 56	Sand, very fine
56- 68	Clay, gray, silty
68- 70	Coal
70-110	Sand, coarse, and gravel, fine

* * * *

Test Hole 17
Location: NE¼NE¼SW¼NW¼ sec. 22, T. 89 N., R. 48 W.
Date Drilled: August 25, 1977
Elevation: 1104

0- 1	Topsoil, gray, silty
1- 10	Clay, gray, silty

Test Hole 17 -- continued.

10- 17	Sand, fine
17- 42	Clay, brown, silty, sandy
42- 70	Clay, gray, silty, with gravel stringers
70- 80	Sand, medium to coarse, silty
80-115	Gravel, fine to medium
115	Sandstone, very fine, cemented

* * * *

Test Hole 18
Location: NW¼NW¼NE¼SE¼ sec. 21, T. 89 N., R. 48 W.
Date Drilled: August 25, 1977
Elevation: 1105

0- 1	Topsoil, brown, sandy
1- 44	Sand, fine
44- 74	Clay, gray, silty, with thin gravel beds
74-147	Gravel, fine to medium
147	Sandstone, very fine, cemented

* * * *

Test Hole 19
Location: NW¼NW¼NE¼SE¼ sec. 21, T. 89 N., R. 48 W.
Date Drilled: August 26, 1977
Elevation: 1106

0- 1	Topsoil, sandy
1- 45	Sand, brown, fine

Observation well: 48 feet of casing; slotted from 13 feet to 48 feet

* * * *

Test Hole 20
Location: SW¼NW¼SE¼NW¼ sec. 9, T. 89 N., R. 48 W.
Date Drilled: August 26, 1977
Elevation: 1093

0- 45	Sand, fine

Observation well: 50 feet of casing; slotted from 10 feet to 45 feet

* * * *

Test Hole 21
Location: NW¼SW¼NE¼NE¼ sec. 9, T. 89 N., R. 48 W.
Date Drilled: August 29, 1977
Elevation: 1098

Test Hole 21 -- continued.

0- 30	Silt, brown, clayey, sandy
30- 64	Sand, fine, very silty
64- 71	Gravel, fine to medium, sandy
71-101	Gravel, medium to coarse
101-111	Silt?
111-136	Gravel, medium
136-150	Bedrock??, soft

* * * *

Test Hole 22
Location: NW¼SW¼NE¼NE¼ sec. 9, T. 89 N., R. 48 W.
Date Drilled: August 30, 1977
Elevation: 1100

0- 30	Silt, brown, clayey, sandy
30- 56	Sand, fine, very silty

Observation well: bottom of well at 56 feet; slotted from 11 feet to 56 feet

* * * *

Test Hole 23
Location: NW¼SE¼NW¼NE¼ sec. 9, T. 89 N., R. 48 W.
Date Drilled: August 30, 1977
Elevation: 1099

0- 51	Sand, fine
51- 72	Silt, brown, clayey
72-101	Gravel, medium, subrounded
101-122	Sand, brown, fine
122-145	Gravel, medium, subrounded

* * * *

Test Hole 24
Location: SW¼SW¼NW¼SE¼ sec. 23, T. 89 N., R. 49 W.
Date Drilled: August 31, 1977
Elevation: 1103

0- 4	Sand, fine
4- 11	Silt, brown, clayey, sandy, fine
11- 22	Sand, brown, fine
22- 36	Sand, black, fine
36- 70	Sand, black, fine, and silt, black to brown, 50 percent sand and 50 percent silt
70- 83	Gravel, medium, round to subround
83-115	Clay, white to gray (chalk?)

* * * *

Test Hole 25
Location: SE¼SE¼NE¼SW¼ sec. 23, T. 89 N., R. 49 W.
Date Drilled: August 31, 1977
Elevation: 1102

0- 3	Sand, fine
3- 11	Silt, brown, clayey, some sand
11- 23	Sand, brown, fine
23- 72	Sand, black, and silt, dark-gray, 50 percent sand and 50 percent silt
72- 77	Gravel, medium

Observation well: bottom of well at 77 feet; slotted from 17 feet to 77 feet

* * * *

Test Hole 26
Location: NW¼SW¼NW¼NE¼ sec. 24, T. 89 N., R. 49 W.
Date Drilled: September 1, 1977
Elevation: 1094

0- 1	Topsoil
1- 54	Sand, brown, fine, with brown clay lenses
54- 57	Sand, coarse to gravel, fine
57- 75	Sand, coarse to gravel, medium, in alternating 1- to 2-foot thick layers
75-103	Gravel, fine to coarse
103-125	Chalk, white

Observation well: bottom of well at 97 feet; slotted from 72 feet to 97 feet

* * * *

Test Hole 27
Location: SE¼SW¼NW¼NE¼ sec. 23, T. 89 N., R. 49 W.
Date Drilled: September 6, 1977
Elevation: 1096

0- 1	Topsoil, tan, silty
1- 11	Clay, gray-tan
11- 41	Sand, fine
41- 48	Gravel, fine to medium
48- 76	Sand, fine
76- 87	Gravel, medium to coarse

Observation well: 83 feet of casing; slotted from 18 feet to 80 feet

* * * *

Test Hole 28
Location: SW¼SW¼NW¼SE¼ sec. 14, T. 89 N., R. 49 W.
Date Drilled: September 7, 1977
Elevation: 1101

0- 1	Topsoil, light-gray, silty
1- 45	Silt, tan-gray, sandy
45- 51	Clay, light-gray, gravelly
51- 99	Gravel, medium, with interbedded sands
99-102	Clay, gravelly
102-105	Gravel, coarse
105-117	Shale, gray-white

* * * *

Test Hole 29
Location: SE¼SE¼SE¼SW¼ sec. 11, T. 89 N., R. 49 W.
Date Drilled: September 7, 1977
Elevation: 1111

0- 1	Topsoil, light-gray, silty
1- 15	Clay, brown
15- 52	Sand, very fine, very silty, gray
52- 54	Sand, fine
54- 84	Gravel, fine to medium
84-106	Gravel, coarse
106-117	Shale, gray-white

* * * *

Test Hole 30
Location: NE¼NE¼NE¼NW¼ sec. 11, T. 89 N., R. 49 W.
Date Drilled: September 7, 1977
Elevation: 1113

0- 1	Topsoil, gray, silty
1- 16	Clay, brown, silty
16- 54	Sand, fine, silty
54- 87	Gravel, fine to medium
87-101	Gravel, coarse
101-119	Gravel, unsorted, and sand, fine to medium
119-147	Silt, light-gray, gravelly

* * * *

Test Hole 31
Location: NW¼NW¼NW¼NE¼ sec. 10, T. 89 N., R. 49 W.
Date Drilled: September 8, 1977
Elevation: 1112

0- 2	Topsoil, dark-brown, silty
2- 14	Clay, brown, silty

Test Hole 31 -- continued.

14- 24	Clay, gray, silty
24- 52	Sand, fine, silty
52- 70	Gravel, fine to medium
70- 99	Gravel, medium to coarse
99-103	Gravel, fine to medium?, silty
103-117	Silt, gray

Observation well: 100 feet of casing; slotted from 67 feet to 97 feet

* * * *

Test Hole 32
Location: SW¼SW¼SW¼SW¼ sec. 35, T. 90 N., R. 49 W.
Date Drilled: September 9, 1977
Elevation: 1116

0- 1	Topsoil, gray, silty
1- 9	Clay, brown, silty
9- 22	Clay, brown-gray, silty
22- 45	Sand, fine, compact, silty
45- 65	Clay, gray, silty, sandy
65- 91	Gravel, fine to medium, shaley
91-124	Gravel, coarse to medium, some coal
124-130	Sand, very coarse, and gravel, fine, silty
130-134	Gravel, coarse
134-147	Shale, light-gray, sandy

* * * *

Test Hole 33
Location: NE¼SW¼NW¼SE¼ sec. 4, T. 89 N., R. 48 W.
Date Drilled: April 27, 1978
Elevation: 1106

0- 2	Topsoil, black
2- 8	Sand, brown,fine
8- 33	Sand, dark-brown to gray, silty
33- 38	Sand, silty, saturated

Observation well: bottom of well at 37 feet; slotted from 17 feet to 37 feet

* * * *

Test Hole 34
Location: NW¼NW¼SE¼SW¼ sec. 4, T. 89 N., R. 48 W.
Date Drilled: April 27, 1978
Elevation: 1106

Test Hole 34 -- continued.

0- 2	Topsoil, black
2- 32	Sand, brown, fine
32- 37	Sand, fine and gravel, fine, brown

Observation well: bottom of well at 37 feet; slotted from 17 feet to 37 feet

* * * *

Test Hole 35
Location: NE¼SE¼SE¼NE¼ sec. 8, T. 89 N., R. 48 W.
Date Drilled: April 27, 1978
Elevation: 1100

0- 2	Topsoil, black
2- 8	Clay, brown, sandy
8- 37	Sand, brown, fine

Observation well: bottom of well at 37 feet; slotted from 17 feet to 37 feet

* * * *

Test Hole 36
Location: SW¼SW¼SW¼NW¼ sec. 4, T. 89 N., R. 48 W.
Date Drilled: April 28, 1978
Elevation: 1103

0- 2	Topsoil, black
2- 28	Clay, silty, very soft
28- 37	Silt, brown, very sandy

Observation well: bottom of well at 37 feet; slotted from 17 feet to 37 feet

* * * *

Test Hole 37
Location: SW¼SW¼SW¼SW¼ sec. 33, T. 90 N., R. 48 W.
Date Drilled: April 28, 1978
Elevation: 1108

0- 2	Topsoil, black
2- 33	Clay, brown, silty, very soft
33- 37	Silt, brown, sandy, soft

Observation well: bottom of well at 37 feet; slotted from 17 feet to 37 feet

* * * *

Test Hole 38
Location: SW¼SW¼SW¼SW¼ sec. 3, T. 89 N., R. 48 W.
Date Drilled: April 28, 1978
Elevation: 1108

0- 2	Topsoil, black
2- 11	Clay, gray to brown
11- 37	Sand, brown, very silty, very soft

Observation well: bottom of well at 37 feet; slotted from 17 feet to 37 feet

* * * *

Test Hole 39
Location: SW¼SW¼SE¼NW¼ sec. 10, T. 89 N., R. 48 W.
Date Drilled: April 28, 1978
Elevation: 1105

0- 2	Topsoil, black
2- 15	Clay, gray, hard
15- 37	Clay, brown, sandy, soft

Observation well: bottom of well at 37 feet; slotted from 17 feet to 37 feet

* * * *

Test Hole 40
Location: SE¼SW¼SE¼SW¼ sec. 10, T. 89 N., R. 48 W.
Date Drilled: April 28, 1978
Elevation: 1109

0- 2	Topsoil
2- 15	Clay, gray, hard
15- 37	Clay, brown, sandy, silty, very soft

Observation well: bottom of well at 37 feet; slotted from 17 feet to 37 feet

* * * *

Test Hole 41
Location: NW¼NE¼SW¼SW¼ sec. 9, T. 89 N., R. 48 W.
Date Drilled: May 2, 1978
Elevation: 1092

0- 2	Topsoil, black, sandy
2- 37	Sand, brown, fine to medium

Test Hole 41 -- continued.

Observation well: bottom of well at 37 feet; slotted from 17 feet to 37 feet

* * * *

Test Hole 42
Location: SE¼SE¼NE¼NE¼ sec. 17, T. 89 N., R. 48 W.
Date Drilled: May 2, 1978
Elevation: 1105

0- 2	Topsoil, black, sandy
2- 9	Sand, brown, fine
9- 28	Clay, brown, very silty
28- 37	Silt, brown, clayey, some sand

Observation well: bottom of well at 37 feet; slotted from 17 feet to 37 feet

* * * *

Test Hole 43
Location: NE¼NW¼SE¼SE¼ sec. 17, T. 89 N., R. 48 W.
Date Drilled: May 2, 1978
Elevation: 1095

0- 6	Sand, brown, fine
6- 37	Silt, brown, and sand, brown, fine

Observation well: bottom of well at 37 feet; slotted from 17 feet to 37 feet

* * * *

Test Hole 44
Location: NE¼NW¼NW¼NE¼ sec. 4, T. 89 N., R. 48 W.
Date Drilled: May 2, 1978
Elevation: 1105

0- 2	Topsoil, black
2- 12	Clay, gray, compact
12- 37	Silt, brown, sandy

Observation well: bottom of well at 37 feet; slotted from 17 feet to 37 feet

* * * *

Test Hole 45
Location: NE¼NW¼SE¼NW¼ sec. 16, T. 89 N., R. 48 W.
Date Drilled: May 4, 1978
Elevation: 1093

0- 2	Topsoil, black
2- 11	Silt, brown to black, sandy
11- 37	Sand, black to brown, fine, some silt

Observation well: bottom of well at 37 feet; slotted from 17 feet to 37 feet

* * * *

Test Hole 46
Location: SW¼SW¼SE¼NW¼ sec. 22, T. 89 N., R. 48 W.
Date Drilled: May 4, 1978
Elevation: 1103

0- 2	Topsoil, black
2- 15	Sand, brown, fine, very silty
15- 30	Silt, black to brown, very sandy
30- 37	Silt, black to brown, sandy, compact

Observation well: bottom of well at 37 feet; slotted from 17 feet to 37 feet

* * * *

Test Hole 47
Location: SE¼SW¼NE¼SW¼ sec. 15, T. 89 N., R. 48 W.
Date Drilled: May 4, 1978
Elevation: 1102

0- 2	Topsoil
2- 15	Silt, brown, clayey, some sand
15- 24	Silt, brown to black, clayey
24- 31	Sand, brown to black, fine, silty
31- 37	Silt, brown, very sandy

Observation well: bottom of well at 37 feet; slotted from 17 feet to 37 feet

* * * *

Test Hole 48
Location: NW¼NE¼NE¼SE¼ sec. 23, T. 89 N., R. 49 W.
Date Drilled: May 30, 1978
Elevation: 1098

Test Hole 48 -- continued.

0- 1	Topsoil, black
1- 21	Sand, brown, fine
21- 42	Sand, black to brown, some clay lenses
42- 51	Gravel, medium, some sand, fine to coarse
51- 73	Silt, gray, sandy, with some gravel
73-100	Gravel, fine to medium
100-110	Clay, white to gray, compact (chalk?)

* * * *

Test Hole 49
Location: NE¼NW¼NW¼SW¼ sec. 23, T. 89 N., R. 49 W.
Date Drilled: June 1, 1978
Elevation: 1099

0- 2	Topsoil, black, sandy
2- 17	Sand, brown, fine
17- 42	Sand, black to brown, fine
42- 60	Silt, black to gray, some sand
60- 99	Gravel, fine to very coarse, much coal, some sand
99-110	Silt, white to gray, very compact (chalk??)

Observation well: bottom of well at 97 feet; slotted from 77 feet to 97 feet

* * * *

Test Hole 50
Location: SE¼SE¼SE¼SW¼ sec. 26, T. 89 N., R. 48 W.
Date Drilled: June 1, 1978
Elevation: 1094

0- 2	Topsoil, black, sandy
2- 75	Sand, brown, fine, some gravel layers, 6 inches to 1 foot thick; medium to coarse
75-130	Gravel, medium to coarse, well rounded

Observation well: bottom of well at 37 feet; slotted from 17 feet to 37 feet

* * * *

Test Hole 51
Location: NE¼NE¼NE¼SE¼ sec. 27, T. 89 N., R. 48 W.
Date Drilled: June 2, 1978
Elevation: 1095

0- 3	Topsoil, black, clayey

Test Hole 51 -- continued.

3- 65	Sand, brown, fine
65- 95	Gravel, fine to medium, and sand, coarse
95-120	Gravel, medium to coarse
120	Rock or hard layer, no penetration at all

* * * *

Test Hole 52
Location: SE¼SE¼NE¼SE¼ sec. 24, T. 90 N., R. 49 W.
Date Drilled: June 2, 1978
Elevation: 1105

0- 2	Sand, brown, fine
2- 46	Silt, gray, soft, some sand, fine
46- 53	Gravel, fine to medium
53- 73	Silt, gray, soft, some brown layers with gravel stringers 1 foot to 2 feet thick, fine
73-100	Gravel, very coarse, 1 inch to 2 inches in diameter, very angular, gravel too coarse to drill through, abandoned hole

* * * *

Test Hole 53
Location: NE¼NE¼SE¼SE¼ sec. 24, T. 90 N., R. 50 W.
Date Drilled: June 5, 1978
Elevation: 1125

0- 1	Topsoil
1- 9	Sand, brown, fine
9- 21	Silt, brown, soft
21- 33	Sand, brown, fine
33- 62	Gravel, medium to fine
62-110	Gravel, medium to very coarse

* * * *

Test Hole 54
Location: NW¼NW¼NE¼NW¼ sec. 24, T. 90 N., R. 50 W.
Date Drilled: June 5, 1978
Elevation: 1120

0- 1	Topsoil
1- 13	Sand, brown, fine
13- 29	Silt, brown, soft
29- 64	Gravel, fine to medium
64-110	Gravel, medium to very coarse
	Observation well: bottom of well at 37 feet; slotted from 17 feet to 37 feet

* * * *

Test Hole 55
Location: SW¼SW¼SW¼SE¼ sec. 12, T. 90 N., R. 50 W.
Date Drilled: June 6, 1978
Elevation: 1124

0- 2	Topsoil
2- 7	Sand, brown, fine
7- 21	Clay, brown, silty
21- 27	Silt, black, sandy
27- 43	Sand, brown to black, fine
43- 48	Gravel, fine to medium, and sand, fine
48- 91	Clay, gray, very silty
91-102	Gravel, medium to coarse
102-110	Clay, gray to white, compact (chalk??)

* * * *

Test Hole 56
Location: NE¼NE¼NE¼SE¼ sec. 1, T. 90 N., R. 50 W.
Date Drilled: June 6, 1978
Elevation: 1117

0- 1	Topsoil, black
1- 8	Sand, brown, fine
8- 33	Silt, brown, soft
33- 61	Silt, brown to gray, very sandy
61- 94	Sand, brown, fine, very silty
94-120	Gravel, medium to coarse

* * * *

Test Hole 57
Location: NW¼NW¼SW¼SW¼ sec. 30, T. 91 N., R. 49 W.
Date Drilled: June 6, 1978
Elevation: 1123

0- 2	Topsoil
2- 36	Sand, fine, and silt, approximately 50 percent sand and 50 percent silt
36- 72	Clay, gray, sandy, pebbly
72-100	Gravel, fine to coarse, some sand

Observation well: bottom of well at 37 feet; slotted from 17 feet to 37 feet

* * * *

Test Hole 58
Location: NE¼NW¼NW¼NE¼ sec. 36, T. 89 N., R. 48 W.
Date Drilled: July 10, 1978
Elevation: 1084

Test Hole 58 -- continued.

0- 6	Sand, brown, fine, silty
6- 35	Sand, brown, fine
35- 50	Sand, brown, fine, silty, gray

Observation well: bottom of well at 43 feet; 4-inch diameter, sandpoint from 38 feet to 43 feet (0.018 slot)

* * * *

Test Hole 59
Location: NW¼NW¼NW¼NE¼ sec. 36, T. 91 N., R. 50 W.
Date Drilled: July 11, 1978
Elevation: 1110

0- 30	Sand, brown, fine

Observation well: bottom of well at 23 feet; 4-inch diameter, sandpoint from 18 feet to 23 feet (0.018 slot)

* * * *

Test Hole 60
Location: NW¼SW¼SE¼NW¼ sec. 22, T. 89 N., R. 49 W.
Date Drilled: July 17, 1978
Elevation: 1100

0- 1	Topsoil, brown, sandy, silty
1- 50	Sand, brown, fine

Observation well: bottom of well at 42 feet; 4-inch diameter; slotted from 27 feet to 37 feet, sandpoint from 37 feet to 42 feet

* * * *

Water Sample No.	Well Controller	Location*
W26	Flynn	SE¼,SE¼,SE¼,NE¼, Sec. 4, T.89N., R.48W.
W27	Waters	NE¼,NE¼,NE¼,SW¼, Sec. 2, T.89N., R.48W.
W28	Stoakly	SW¼,NW¼,SW¼,NW¼, Sec. 31, T.91N., R.48W.
W29	Hofwolt	NE¼,NE¼,NE¼,NE¼, Sec. 28, T.91N., R.49W.
W30	Chicoine	SW¼,SW¼,SW¼,NW¼, Sec. 1, T.91N., R.49W.
W31	Hemingson	SE¼,SE¼,NE¼,SE¼, Sec. 1, T.90N., R.49W.
W32	Corio	NE¼,NE¼,NE¼,SE¼, Sec. 15, T.89N., R.49W.
W33	S.D.G.S.	SE¼,SE¼,NE¼,SE¼, Sec. 23, T.89N., R.49W.
W34	S.D.G.S.	NW¼,SW¼,NW¼,NE¼, Sec. 24, T.89N., R.49W.
W35	S.D.G.S.	SE¼,SW¼,NW¼,NE¼, Sec. 23, T.89N., R.49W.
W36	S.D.G.S.	NW¼,NW¼,NW¼,NE¼, Sec. 10, T.89N., R.49W.
W37		NW¼,SW¼,SE¼,NW¼, Sec. 24, T.89N., R.49W.
W38	S.D.G.S.	SE¼,SE¼,SE¼,SW¼, Sec. 26, T.89N., R.48W.
W39	S.D.G.S.	NE¼,NW¼,NW¼,SW¼, Sec. 23, T.89N., R.49W.
W40	S.D.G.S.	NW¼,NW¼,NE¼,NW¼, Sec. 25, T.90N., R.50W.
W41	S.D.G.S.	NW¼,NW¼,SW¼,SW¼, Sec. 30, T.91N., R.49W.
W42	S.D.G.S.	NE¼,NW¼,NW¼,NE¼, Sec. 36, T.89N., R.48W.
W43	S.D.G.S.	NE¼,NW¼,NW¼,NE¼, Sec. 36, T.89N., R.48W.
W44	S.D.G.S.	NE¼,NW¼,NW¼,NE¼, Sec. 36, T.89N., R.48W.
W45	S.D.G.S.	NE¼,NW¼,NW¼,NE¼, Sec. 36, T.89N., R.48W.
W46	S.D.G.S.	NE¼,NW¼,NW¼,NE¼, Sec. 36, T.89N., R.48W.
W47	S.D.G.S.	NW¼,NW¼,NW¼,NE¼, Sec. 36, T.91N., R.50W.
W48	S.D.G.S.	NW¼,NW¼,NW¼,NE¼, Sec. 36, T.91N., R.50W.
W49	S.D.G.S.	NW¼,NW¼,NW¼,NE¼, Sec. 36, T.91N., R.50W.
W50	S.D.G.S.	NW¼,SW¼,SE¼,NW¼, Sec. 22, T.89N., R.49W.
W51	S.D.G.S.	NW¼,SW¼,SE¼,NW¼, Sec. 22, T.89N., R.49W.

Water Sample No.	Well Controller	Location*
W52	S.D.G.S.	NW¼,SW¼,SE¼,NW¼, Sec. 22, T.89N., R.49W.
W53	S.D.G.S.	NW¼,SW¼,SE¼,NW¼, Sec. 22, T.89N., R.49W.
W54	S.D.G.S.	NW¼,NW¼,NW¼,NE¼, Sec. 36, T.91N., R.50W.
W55	S.D.G.S.	NW¼,NW¼,NW¼,NE¼, Sec. 36, T.91N., R.50W.
W56	S.D.G.S.	NW¼,NW¼,NW¼,NE¼, Sec. 36, T.91N., R.50W.
W57		SW¼,NW¼,SE¼,SW¼, Sec. 4, T.89N., R.48W.
W58		SE¼,NE¼,NW¼,SW¼, Sec. 21, T.89N., R.48W.
W59		NE¼,NW¼,NE¼,SW¼, Sec. 14, T.89N., R.48W.

* All locations are based on the South Dakota grid system.

APPENDIX C - Core Sample Logs
(for map locations see figure 3)

Core #1
Location: NE¼,SE¼,SW¼,NW¼, Sec. 9, T.89N., R.48W.
Date taken: 2-23-78

0"	-	2"	Sand, very fine
2"	-	130"	Sand, fine
130"	-	140"	Sand, medium

Core #2
Location: NW¼,NW¼,NE¼,NW¼, Sec. 9, T.89N., R.48W.
Date taken: 2-27-78

0"	-	3.5"	Silt, much organic matter
3.5"	-	22"	Silt, unconsolidated
22"	-	33"	Silt, consolidated
33"	-	57"	Sand, fine

Core #3
Location: SW¼,NE¼,SW¼,SE¼, Sec. 4, T.89N., R.48W.
Date taken: 2-27-78

0"	-	2"	Silt, much organic matter
2"	-	4"	Silt
4"	-	7"	Sand, fine
7"	-	10"	Silt, moderate amount of organic matter
10"	-	21"	Sand, fine
21"	-	31"	Silt
31"	-	68"	Sand, fine

Core #4
Location: NE¼,NW¼,NW¼,SW¼, Sec. 9, T.89N., R.48W.
Date taken: 2-28-78

0"	-	5"	Silt, much organic matter
5"	-	65"	Sand, very fine grading to fine

Core #5
Location: NW¼,SW¼,NE¼,NE¼, Sec. 9, T.89N., T.48W.
Date taken: 2-28-78

0"	-	3"	Silt, unconsolidated, much organic matter
3"	-	113"	Silt
113"	-	115"	Sand, fine

Core #6
Location: SW¼,SW¼,SW¼,NW¼, Sec. 10, T.89N., R.48W.
Date taken: 2-28-78

0"	-	38"	Silt
38"	-	58"	Sand, fine

Core #7
Location: SW¼,SW¼,NW¼,SW¼, Sec. 10, T.89N., R.48W.
Date taken: 2-28-78

0"	-	21"	Silt
21"	-	24.5"	Sand, fine
24.5"	-	29.5"	Silt
29.5"	-	65"	Sand, fine

Core #8
Location: SW¼,SW¼,SE¼,SE¼, Sec. 4, T.89N., R.48W.
Date taken: 2-28-78

0"	-	166"	Silt

All locations are based on the South Dakota grid system.

APPENDIX D - Well Inventory

Well Controller	Location	Depth of Well (feet)	Depth to Water (feet)	Geologic Source	Use	Water Sample No.
Winer	NE¼,NW¼,NW¼,NE¼, Sec. 35, T.89N., R.49W.				S&D	
	NW¼,NW¼,NW¼,SW¼, Sec. 26, T.89N., R.48W.				D	
Bruneau	SE¼,NW¼, Sec. 27, T.89N., R.48W.	30		S	D	
Sheeler	NE¼,NW¼, Sec. 27, T.89N., R.48W.	23	23	S	D	
	SW¼,SE¼,SE¼,SW¼, Sec. 22, T.89N., R.48W.			S	S&D	W1
Geode	NW¼,NE¼,NW¼,NW¼, Sec. 27, T.89N., R.48W.	26-30	22	S	D	
Orr	NE¼,NE¼,SW¼,NW¼, Sec. 27, T.89N., R.48W.	45	20-25	S	D	
Wheeler	NE¼,SW¼,NW¼,SE¼, Sec. 21, T.89N., R.48W.	85	25-30		D	
Bruneau	SW¼,SW¼,NE¼,NE¼, Sec. 21, T.89N., R.48W.	95	18	G	S&D	
Bender	NW¼,SE¼, Sec. 21, T.89N., R.48W.	68		S	S&D	
Stark	NW¼,NW¼,NW¼,SE¼, Sec. 22, T.89N., R.48W.	45-50		S	S&D	
Brogh	NW¼,SW¼,NE¼, Sec. 22, T.89N., R.48W.	25			D	
Ullrich	Sec. 15, T.89N., R.48W.				D	
Gruis	Sec. 15, T.89N., R.48W.	30	7		S&D	
Jokerst	Sec. 15, T.89N., R.48W.	30-40			D	
Bernard	NW¼,SW¼,NW¼,SW¼, Sec. 13, T.90N., R.49W.	43		S	S	
Bernard	NW¼,SW¼,NW¼,SW¼, Sec. 13, T.90N., R.49W.	53		S	D	
Monlagne	SW¼,SE¼,SW¼,SE¼, Sec. 14, T.90N., R.49W.	22	22	S	S&D	W2
Dailey	NW¼,SW¼,NW¼,SE¼, Sec. 14, T.89N., R.49W.	40	24	S	D	W3
Dailey	NW¼,SW¼,NW¼,SE¼, Sec. 14, T.89N., R.49W.	104	24	G	S	
Corio	NW¼,NE¼, Sec. 14, T.89N., R.49W.	100			D	
Bogner	NE¼,NE¼,NE¼,NW¼, Sec. 14, T.89N., R.49W.	45	14		D	
Hikeman	SE¼,SW¼,SW¼, Sec. 12, T.89N., R.49W.	75	12	G	S&D	

Well Controller	Location	Depth of Well (feet)	Depth to Water (feet)	Geologic Source	Use	Water Sample No.
Hikeman	SE¼,SW¼,SW¼, Sec. 12, T.89N., R.49W.	93	12	G	I	W4
	NW¼,SW¼, Sec. 7, T.89N., R.48W.	20			S&D	
Dailey	SE¼,SW¼, Sec. 12, T.89N., R.49W.	24			S	
Dailey	SE¼,SW¼, Sec. 12, T.89N., R.49W.	75		G	D	
Dailey	SE¼,SW¼, Sec. 12, T.89N., R.49W.	100		G	I	
Beavers	NE¼,NW¼,NW¼,NW¼, Sec. 7, T.89N., R.48W.	104	17	S	S&D	
Clauson	NW¼,NE¼, Sec. 7, T.89N., R.48W.	105	20	G	I	
Clauson	NW¼,NE¼, Sec. 7, T.89N., R.48W.	15	10	S	D	
Beavers	SW¼,SE¼, Sec. 6, T.89N., R.48W.	24	12	S	D	
Beavers	SW¼,SE¼, Sec. 6, T.89N., R.48W.	104	12	G	I	
Kneebone	NW¼,SW¼, Sec. 6, T.89N., R.48W.	113	18	G	I	
Kneebone	NW¼,SW¼, Sec. 6, T.89N., R.48W.	86	18	G	D	
Kneebone	NW¼,SW¼, Sec. 6, T.89N., R.48W.	29	18	G	S	
Edwards	NE¼,NE¼,SE¼,NE¼, Sec. 25, T.90N., R.49W.	23	18	S	S&D	
Bruneau	NW¼,NE¼,SE¼,SW¼, Sec. 25, T.90N., R.49W.	25	20	S	D	
Bernard	NE¼,NW¼,NE¼,SW¼, Sec. 25, T.90N., R.49W.	18	16	G	S&D	
Bernard	NE¼,NW¼,NE¼,SW¼, Sec. 25, T.90N., R.49W.	26	18	G	S&D	
Dean	NW¼,NW¼,NW¼,NW¼, Sec. 25, T.90N., R.49W.	40	20	S	D	
Dean	NW¼,NW¼,NW¼,NW¼, Sec. 25, T.90N., R.49W.	30	22	S	S	
Bernard	SE¼,NW¼,SW¼, Sec. 24, T.90N., R.49W.	105		S	S	
Bernard	SE¼,NW¼,SW¼, Sec. 24, T.90N., R.49W.	30	30	S	D	
Bellenger	NW¼,NE¼,SW¼, Sec. 13, T.90N., R.50W.	88		G	D	
Bellenger	NW¼,NE¼,SW¼, Sec. 13, T.90N., R.50W.	120		G	I	

Well Controller	Location	Depth of Well (feet)	Depth to Water (feet)	Geologic Source	Use	Water Sample No.
Rosale	NW¼,SE¼,NE¼,SE¼, Sec. 13, T.90N., R.50W.	20-25	12-14	S	D	W5
Squies	NE¼,NE¼,NE¼,NE¼, Sec. 24, T.90N., R.50W.	20			D	
Rodbub	SW¼,SW¼,NW¼,SW¼, Sec. 20, T.90N., R.49W.	85	12		D	W6
Rodbub	SW¼,SW¼,NW¼,SW¼, Sec. 20, T.90N., R.49W.	24	17		D	
Alard	NW¼,SW¼, Sec. 19, T.90N., R.49W.	95	18	G	S&D	
Banet	SW¼,SE¼,SE¼,SE¼, Sec. 17, T.90N., R.49W.				D	
Alvison	SW¼,SW¼, Sec. 16, T.90N., R.49W.	25-30			D	W7
Rosenbaum	NE¼,NE¼,NE¼, Sec. 20, T.90N., R.49W.	30-40	20	S	S&D	
Oberg	NE¼,NE¼,NE¼,SE¼, Sec. 20, T.90N., R.49W.			S	D	
Rosenbaum	NE¼,NE¼,SE¼,SE¼, Sec. 20, T.90N., R.49W.	83		G	S&D	
Donely	SW¼,NE¼,NW¼,SW¼, Sec. 21, T.90N., R.49W.	20	20	S	D	
Donely	SW¼,NE¼,NW¼,SW¼, Sec. 21, T.90N., R.49W.	100	20	S	I	
Rosenbaum	SE¼,SE¼,SE¼,SE¼, Sec. 20, T.90N., R.49W.	24		S	S&D	
Rosenbaum	SW¼,NE¼,NE¼,SE¼, Sec. 32, T.90N., R.49W.	18	9	S	D	W8
Wood	NE¼,NE¼,SE¼,SE¼, Sec. 29, T.90N., R.49W.	17		S	S&D	
Doodle	NE¼,NW¼,NW¼,NW¼, Sec. 28, T.90N., R.49W.	26		S	D	
Harkness	NW¼,SW¼,SE¼,NW¼, Sec. 27, T.90N., R.49W.	27	20	S	D	W9
James	SW¼,SW¼, Sec. 16, T.90N., R.49W.				D	
Corio	NE¼,NW¼,NE¼,SE¼, Sec. 21, T.90N., R.49W.	25		S	D	W10
Corio	NE¼,NW¼,NE¼,SE¼, Sec. 21, T.90N., R.49W.	100		G	I	
Bernard	SW¼,SE¼,SE¼,SW¼, Sec. 27, T.90N., R.49W.	32	30	S	S&D	
Wilcox	NW¼,SE¼,NE¼,NE¼, Sec. 34, T.90N., R.49W.	28	28	S	D	
Sheepland	NW¼,NE¼,NW¼,SE¼, Sec. 35, T.90N., R.49W.	25	17	S	D	

Well Controller	Location	Depth of Well (feet)	Depth to Water (feet)	Geologic Source	Use	Water Sample No.
Karpen	SW¼,NW¼,SW¼,NW¼, Sec. 2, T.89N., R.49W.	46			D	W11
Mollet	NW¼,NE¼,NE¼,NE¼, Sec. 10, T.89N., R.49W.	100	20		D	
Hamel	SE¼,SE¼,SE¼,NW¼, Sec. 10, T.89N., R.49W.	35			S&D	W12
Elkins	SW¼,NW¼,SW¼,NW¼, Sec. 11, T.89N., R.49W.	20		S	S&D	
Jergenson	NW¼,NW¼,NW¼,NE¼, Sec. 11, T.89N., R.49W.	31	12		S&D	
Nearman	NE¼,SE¼,SE¼,SE¼, Sec. 3, T.89N., R.49W.	20-25	15	S	S&D	
Karpen	NW¼,SW¼,NW¼,SW¼, Sec. 2, T.89N., R.49W.	35		S	D	
Milton	NE¼,NE¼,SE¼,SE¼, Sec. 27, T.90N., R.49W.				D	
Wilkox	NE¼,NW¼,NW¼,NW¼, Sec. 35, T.90N., R.49W.	30			D	W13
Wriedt	SW¼,SE¼,SW¼,SW¼, Sec. 26, T.90N., R.49W.	25	20	S	S&D	
Burner	NW¼,NW¼,NW¼,NE¼, Sec. 35, T.90N., R.49W.	30			D	
Bertrand	NE¼,SE¼,NE¼,SE¼, Sec. 27, T.90N., R.49W.	32	32	S	S&D	
	SE¼,NE¼, Sec. 27, T.90N., R.49W.	20			S&D	
Minor	NW¼,NW¼, Sec. 26, T.90N., R.49W.			S	D	
Huntsman	NW¼,NW¼,NW¼,NW¼, Sec. 26, T.90N., R.49W.	38			S&D	
	SW¼,SE¼,SE¼,SE¼, Sec. 24, T.90N., R.49W.	28	28		S&D	W14
	SW¼,SE¼,SE¼,SE¼, Sec. 24, T.90N., R.49W.	24	24		S&D	
Pomerico	NE¼,SE¼,NE¼,NE¼, Sec. 25, T.90N., R.49W.	22	22	S	D	
Smith	SW¼,SW¼,SW¼,SE¼, Sec. 30, T.90N., R.48W.	22	19	S	S&D	W15
Johnson	SE¼,SE¼, Sec. 30, T.90N., R.48W.	15	14	S	D	
Fleshner	NE¼,NE¼,NE¼,NW¼, Sec. 32, T.90N., R.48W.				S&D	
Chicoine	NE¼,NE¼,NE¼,SE¼, Sec. 32, T.90N., R.48W.	60	16		S&D	W16
Trudea	NE¼,NE¼,SE¼,SE¼, Sec. 32, T.90N., R.48W.	35		G	S&D	

Well Controller	Location	Depth of Well (feet)	Depth to Water (feet)	Geologic Source	Use	Water Sample No.
Jenson	SW¼,SE¼,SE¼,SW¼, Sec. 32, T.90N., R.48W.	30		S	S&D	
	NE¼,NE¼,NE¼,SE¼, Sec. 5, T.89N., R.48W.	40	30		D	
Priborsky	SE¼,NE¼,NE¼,SE¼, Sec. 5, T.89N., R.48W.				S&D	W17
Camel	SE¼, Sec. 36, T.90N., R.49W.	21		S	S&D	
Camel	SE¼, Sec. 36, T.90N., R.49W.	90	11	G	I	
Minor	SW¼,SE¼,SE¼, Sec. 36, T.90N., R.49W.	16	15	S	S&D	W18
Fornea	NW¼,SW¼,SW¼,NW¼, Sec. 21, T.90N., R.48W.	27			S&D	W19
Fornea	NW¼,SW¼,SW¼,NW¼, Sec. 21, T.90N., R.48W.	75		G	I	
McCarthy	SE¼,SE¼,NE¼,NE¼, Sec. 28, T.90N., R.48W.				S&D	W20
Green	NW¼,SW¼,NE¼,NW¼, Sec. 34, T.90N., R.48W.				S&D	W21
Mollet	NE¼,SE¼,SE¼,NE¼, Sec. 29, T.90N., R.48W	24	22		D	
Ballinger	SW¼,SW¼,SW¼,NW¼, Sec. 18, T.90N., R.49W.	60		S	D	
Cates	NE¼,NE¼,NE¼,NW¼, Sec. 13, T.90N., R.50W.			S	D	
Bloomberg	NW¼,NE¼,NW¼,NW¼, Sec. 18, T.90N., R.49W.	40			D	
Lange	SW¼,SW¼,SE¼,SW¼, Sec. 7, T.90N., R.49W.				D	
	SW¼,SW¼,SE¼, Sec. 7, T.90N., R.49W.	36	15	S	S&D	W22
Rosenbaum	NW¼,SW¼,SW¼,NW¼, Sec. 17, T.90N., R.49W.	30	13	S	S&D	
Pace	SE¼,NE¼,NE¼,SE¼, Sec. 18, T.90N., R.49W.				D	
Brown	SW¼,SW¼,NW¼,SW¼, Sec. 17, T.90N., R.49W.	22		S	S&D	
	SW¼,NW¼,NW¼,SW¼, Sec. 8, T.90N., R.49W.	30-40			D	
Morris	NE¼,SE¼,NE¼, Sec. 7, T.90N., R.49W.	30			D	
Connly	SE¼,SW¼,SE¼,SW¼, Sec. 5, T.90N., R.49W.	30-35	25	S	S&D	
Meingenberg	NE¼,NE¼,SE¼,NE¼, Sec. 6, T.90N., R.49W.				D	
George	SW¼,SW¼,NW¼,NW¼, Sec. 5, T.90N., R.49W.	104	20		I	

Well Controller	Location	Depth of Well (feet)	Depth to Water (feet)	Geologic Source	Use	Water Sample No.
George	SW¼,SW¼,NW¼,NW¼, Sec. 5, T.90N., R.49W.	75	20		S&D	
Geary	NW¼,NW¼,NE¼, Sec. 6, T.90N., R.49W.				S&D	
Georgon	SW¼,SW¼,SW¼,NW¼, Sec. 4, T.90N., R.49W.			S	D	W23
Smith	NE¼,NE¼,NE¼,NE¼, Sec. 8, T.90N., R.49W.	30			S&D	
Gold	NE¼,NE¼,SE¼,NE¼, Sec. 8, T.90N., R.49W.				D	
Chicoine	NW¼,NW¼,NW¼,SW¼, Sec. 9, T.90N., R.49W.				S&D	W24
Chicoine	SE¼,SE¼,NE¼,SE¼, Sec. 9, T.90N., R.49W.	40	10		S	
Fuller	NW¼,NW¼,NW¼,NW¼, Sec. 10, T.90N., R.49W.	15	15	G	D	
Douglas	NE¼,NE¼,NE¼,NE¼, Sec. 15, T.90N., R.49W.	70			D	W25
Montagne	SE¼,SE¼,NE¼,SE¼, Sec. 10, T.90N., R.49W.	82	30	G	D	
Chicoine	NW¼,NW¼,NW¼,NE¼, Sec. 14, T.90N., R.49W.	35	28			
Merrile	SE¼,SE¼,SE¼,SW¼, Sec. 11, T.90N., R.49W.	32		S	D	
Buddle	NW¼,SE¼,SW¼,SW¼, Sec. 11, T.90N., R.49W.	30	25	S	D	
Flynn	SE¼,SE¼,SE¼,NE¼, Sec. 4, T.89N., R.48W.	75			D	W26
Donhaime	SE¼,SW¼,SE¼,SW¼, Sec. 3, T.89N., R.48W.	85	20	G	S&D	
Waters	NE¼,NE¼,NE¼,SW¼, Sec. 2, T.89N., R.48W.	150	18	S	S&D	W27
Stekel	SE¼, Sec. 25, T.91N., R.49W.	100	13		I	
Stekel	NW¼,NW¼,NW¼,SE¼, Sec. 25, T.91N., R.49W.	80	13		D	
Stoakly	SW¼,NW¼,SW¼,NW¼, Sec. 31, T.91N., R.48W.					W28
McGuire	SW¼,SW¼,SW¼,NE¼, Sec. 31, T.91N., R.48W.	32	23		D	
McGuire	NE¼, Sec. 31, T.91N., R.48W.	100	23		I	
Chicoine	NE¼,NE¼,NE¼,NE¼, Sec. 6, T.90N., R.48W.	46			D	
Curran	SW¼,SW¼,SW¼,SW¼, Sec. 5. T.90N., R.48W.	65			D	
Rehling	SE¼,SW¼,SW¼,SE¼, Sec. 20, T.91N., R.49W.	60	12	S	D	

Well Controller	Location	Depth of Well (feet)	Depth to Water (feet)	Geologic Source	Use	Water Sample No.
Rehling	SW¼,SW¼,SE¼,SE¼, Sec. 20, T.91N., R.49W.	100+			D	
Walsh	SE¼,SE¼,SW¼,SW¼, Sec. 21. T.91N., R.49W.	65			S&D	
Limoges	NW¼,NW¼,NE¼,NW¼, Sec. 28, T.91N., R.49W.	50	15	S	S&D	
Walsh	SW¼,SW¼,SW¼,SE¼, Sec. 21, T.91N., R.49W.	65			D	
Hofwolt	NE¼,NE¼,NE¼,NE¼, Sec. 28, T.91N., R.49W.				S&D	W29
Olsen	SW¼,SW¼,NW¼,NW¼, Sec. 27, T.91N., R.49W.			S	D	
Hanson	SW¼,SW¼,SW¼,SE¼, Sec. 22, T.91N., R.49W.	60	15	G	D	
Duhrime	NW¼,NW¼,NW¼,NW¼, Sec. 26, T.91N., R.49W.	101		G	I	
Duhrime	NW¼,NW¼,NW¼,NW¼, Sec. 26, T.91N., R.49W.	65		S	S&D	
Lyle	SE¼,SE¼,SW¼,SE¼, Sec. 23, T.91N., R.49W.	55	18	G	S&D	
Lyle	SE¼, Sec. 23, T.91N., R.49W.	100	18	S	I	
Beermann	NW¼,SW¼,SW¼,SW¼, Sec. 26, T.91N., R.49W.	20	15		D	
Beermann	SW¼, Sec. 26, T.91N., R.49W.	82		S	I	
Walsh	NE¼,SE¼,SE¼,NW¼, Sec. 33, T.91N., R.49W.	50			D	
Walsh	NW¼, Sec. 33, T.91N., R.49W.	110	20	G	I	
Biusseau	SW¼,SW¼,SW¼,SW¼, Sec. 34, T.91N., R.49W.	28	18	S	D	
Chicoine	NW¼, Sec. 35, T.91N., R.49W.	115	20	S	I	
Chicoine	SW¼,SW¼,SW¼,NW¼, Sec. 35, T.91N., R.49W.	50	20	S	S&D	W30
Ramesbotham	SE¼,SE¼,SW¼,SW¼, Sec. 35, T.91N., R.49W.				D	
Bosse	SW¼,SE¼,SW¼,SE¼, Sec. 35, T.91N., R.49W.	80			S&D	
Gill	NW¼,NW¼,SW¼,SW¼, Sec. 36, T.91N., R.49W.	22			D	
Gill	NW¼,NW¼,SW¼,SW¼, Sec. 36, T.91N., R.49W.	45			D	
Berhand	SE¼,SE¼,NE¼,NE¼, Sec. 2, T.90N., R.49W.	68		S	S&D	
Chicoine	NE¼,NE¼,NW¼,NE¼, Sec. 1, T.90N., R.49W.	60	17	G	S&D	

Well Controller	Location	Depth of Well (feet)	Depth to Water (feet)	Geologic Source	Use	Water Sample No.
Celley	SE¼, Sec. 1, T.90N., R.49W.				D	
Hemingson	SE¼,SE¼,NE¼,SE¼, Sec. 1, T.90N., R.49W.	60	23	S	S&D	W31
	NW¼,SW¼,SE¼,SW¼, Sec. 1, T.90N., R.49W.				S&D	
Chicoine	SE¼,SE¼,SE¼,NE¼, Sec. 7, T.90N., R.48W.	18			D	
Bosse	NW¼,SW¼,SW¼,NW¼, Sec. 12, T.90N., R.49W.	32			S&D	
Chicoine	SW¼,NE¼,NE¼,SE¼, Sec. 11, T.90N., R.49W.	83			S	
Chicoine	SW¼,NE¼,NE¼,SE¼, Sec. 11, T.90N., R.49W.	20			S	
Felton	NE¼,SE¼,NE¼,NW¼, Sec. 11, T.90N., R.49W.	80	20	S	D	
Anderson	SW¼,SW¼,SW¼,SE¼, Sec. 2, T.90N., R.49W.	20			S	
Anderson	SW¼,SW¼,SW¼,SE¼, Sec. 2, T.90N., R.49W.	65			S	
Schmitz	NW¼,SE¼,SW¼,SW¼, Sec. 2, T.90N., R.49W.	65	14	G	S&D	
Schmitz	NW¼,SE¼,SW¼,SW¼, Sec. 2, T.90N., R.49W.	35	14	S	S&D	
Brusseau	SW¼,SE¼,NE¼,NW¼, Sec. 3, T.90N., R.49W.	32	17		S&D	
Singer	SW¼,SW¼,SE¼,NW¼, Sec. 34, T.91N., R.49W.	40	10		S&D	
Chicoine	NE¼,NE¼,NE¼,SE¼, Sec. 15, T.89N., R.49W.	92				W32

Geologic Source: S, sand; G, gravel

Use: D, domestic; S, stock; I, irrigation

All locations are based on the South Dakota grid system.

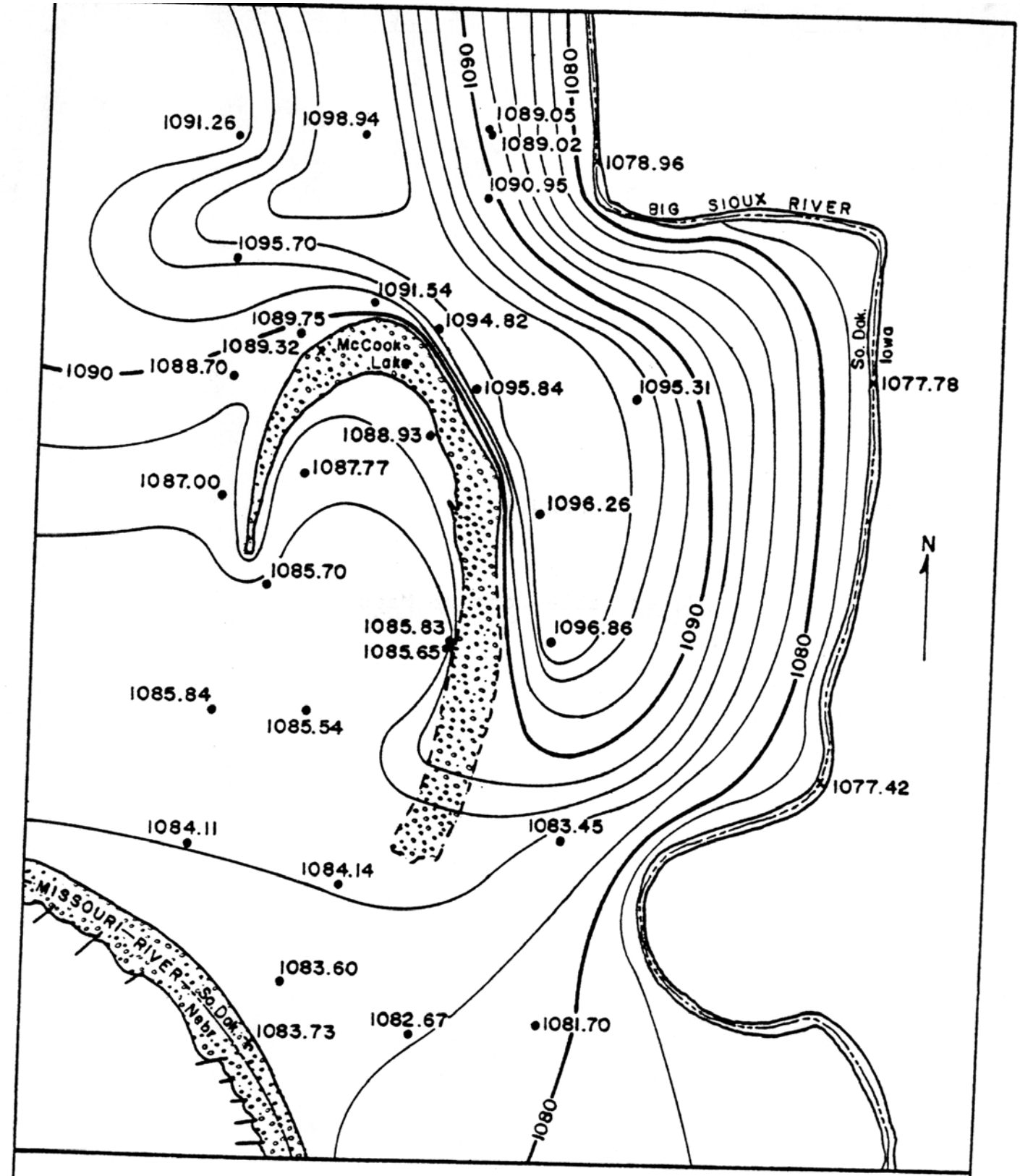
APPENDIX E - Water Elevations in McCook Lake Observation Wells

Observation Well No.	Elevation of water (in feet above mean sea level)						
	5-16-78	6-6-78	6-19-78	6-29-78	7-17-78	7-28-78	8-11-78
2	1084.14	1084.50	1084.48	1085.05	1086.49	1087.31	1087.80
3	1083.60	1084.55	1083.92	1084.11	1085.96	1087.28	1087.64
4	1088.32	1088.37	1090.70	1088.17	1089.84	1088.84	1089.26
5	1085.83	1085.81	1085.57	1085.51	1086.23	1087.28	1087.81
6	1085.65	1085.87	1085.35	1085.66	1086.22	1087.33	1087.86
7	1094.82	1094.65	1093.54	1093.67	1092.86	1094.60	1095.25
8	1087.52	1087.50	1086.89	1087.30	1087.28	1088.34	1088.80
9	1095.31	1096.34	1095.99	1095.96	1096.72	1096.40	1097.38
10	1089.05	1089.04	1088.14	1088.64	1085.46	1089.33	1089.83
11	1089.02	1089.01	1088.21	1088.83	1087.58	1089.33	1089.74
13	1090.95	1090.96	1089.34	1089.96	1089.74	1091.37	1091.60
15	1088.70	1088.61	1087.92	1087.96	1088.04	1088.93	1089.20
19	1082.67	1083.11	1083.30	1083.36	1085.95	1085.34	1085.98
20	1087.77	1087.65	1087.23	1087.31	1087.69	1088.11	1088.59
22	1088.93	1088.89	1088.46	1088.88	1088.67	1089.45	1089.96
33	1091.54	1091.75	1091.71	1091.61	1091.48	1092.13	1092.60
34	1089.75	1089.63	1089.10	1089.80	1088.88	1089.98	1090.34
35	1087.00	1086.88	1086.46	1086.46	1086.80	1087.24	1087.59
36	1095.70	1094.80	1092.61	1093.26	1093.11	1093.92	1094.37
37	1091.26	1091.14	1090.53	1090.29	1090.11	1091.11	1091.48
38	1095.84	1095.79	1095.12	1094.90	1094.68	1096.00	1097.45
39	1096.29	1096.67	1095.68	1095.04	1094.51	1096.76	1096.80
40	1096.86	1096.22	1095.00	1094.69	1097.06	1097.56	1098.25

Observation Well No.	Elevation of Water (in feet above mean sea level)						
	5-16-78	6-6-78	6-19-78	6-29-78	7-17-78	7-28-78	8-11-78
41	1085.70	1085.67	1084.56	1085.35	1086.48	1086.13	1086.65
42	1085.84	1085.87	1085.45	1085.69	1085.64	1086.93	1087.48
43	1084.11	1084.97	1084.78	1086.45	1082.09	1083.69	1087.81
44	1098.94	1099.36	1097.86	1097.63	1097.65		1100.65
45	1085.54	1085.66	1085.57	1085.43	1086.10	1086.54	1087.29
46	1081.70	1081.86	1082.06	1082.32	1088.76	1083.69	1084.40
47	1083.45	1083.51	1083.25	1083.75	1084.10	1085.26	1087.34

APPENDIX F

Water Table Contour Maps



Map Showing Water Table Contours

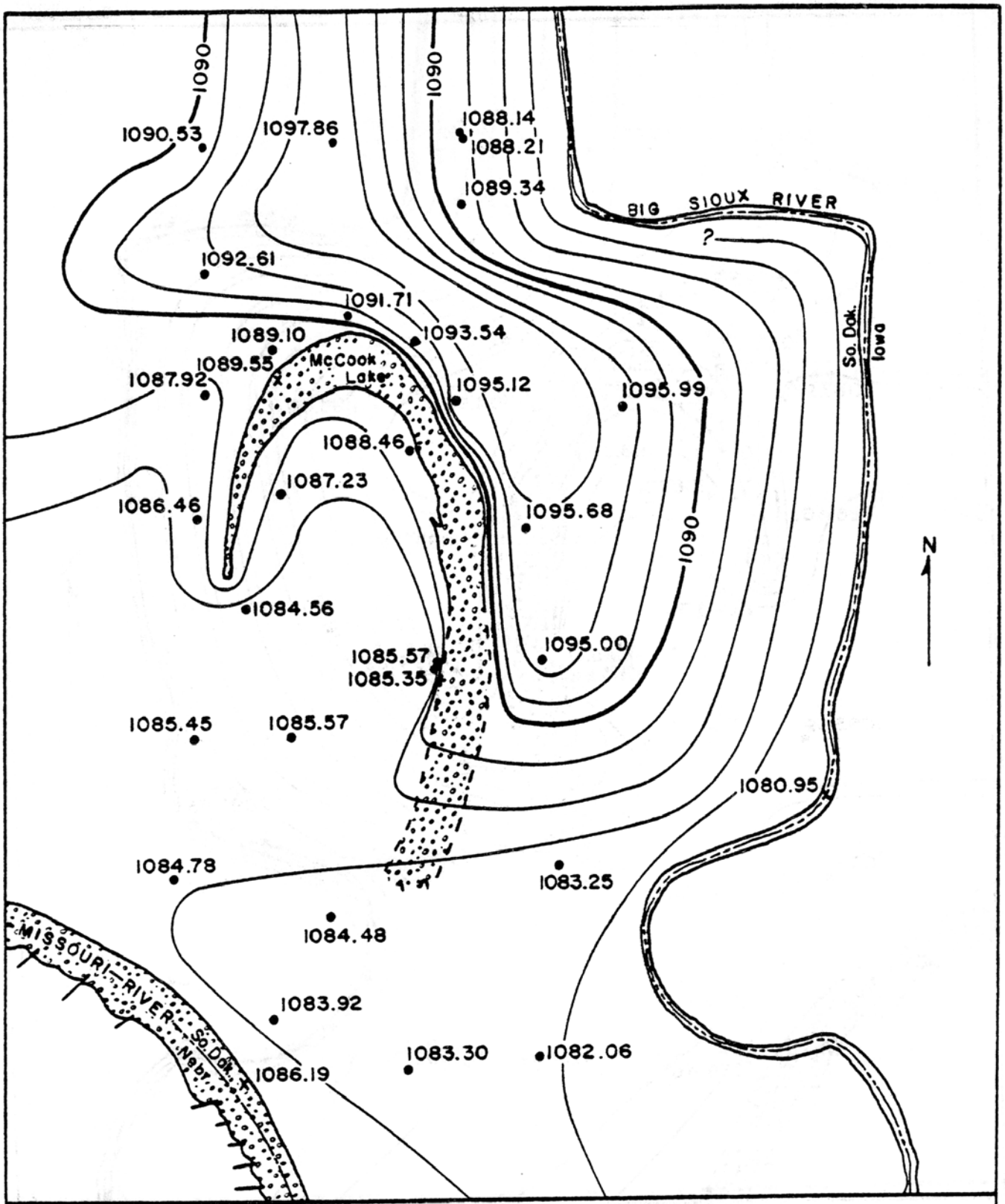
1021.11 • Observation well - number indicates water level above mean sea level.

1021.11 x Surface water - number indicates water level above mean sea level.

Contour Interval 2 feet

Data taken 5/16-24/78

1 Mile



Map Showing Water Table Contours

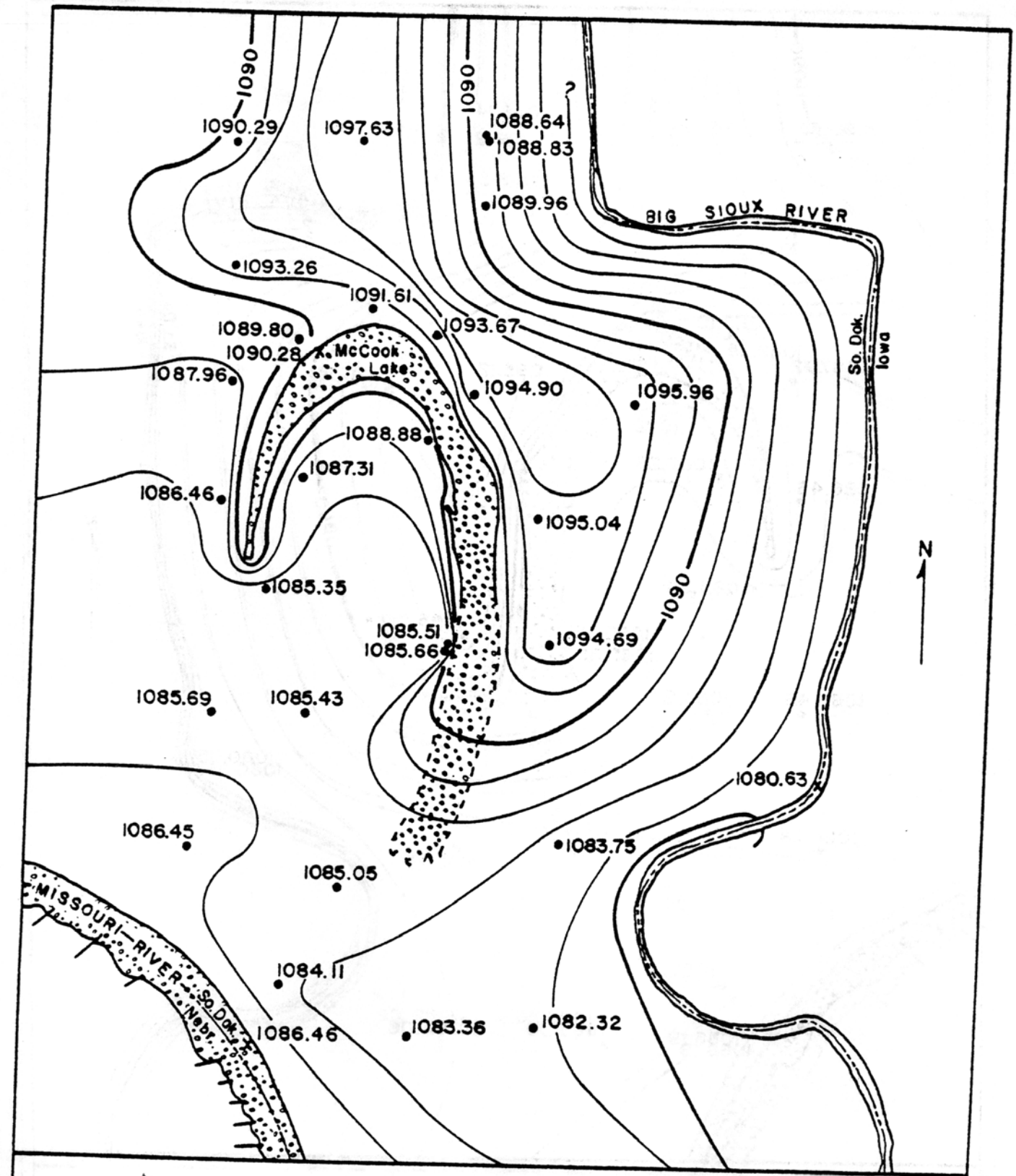
1021.11 • Observation well - number indicates water level above mean sea level.

1021.11 x Surface water - number indicates water level above mean sea level.

Contour Interval 2 feet

Data taken 6/19/78

1 Mile



Map Showing Water Table Contours

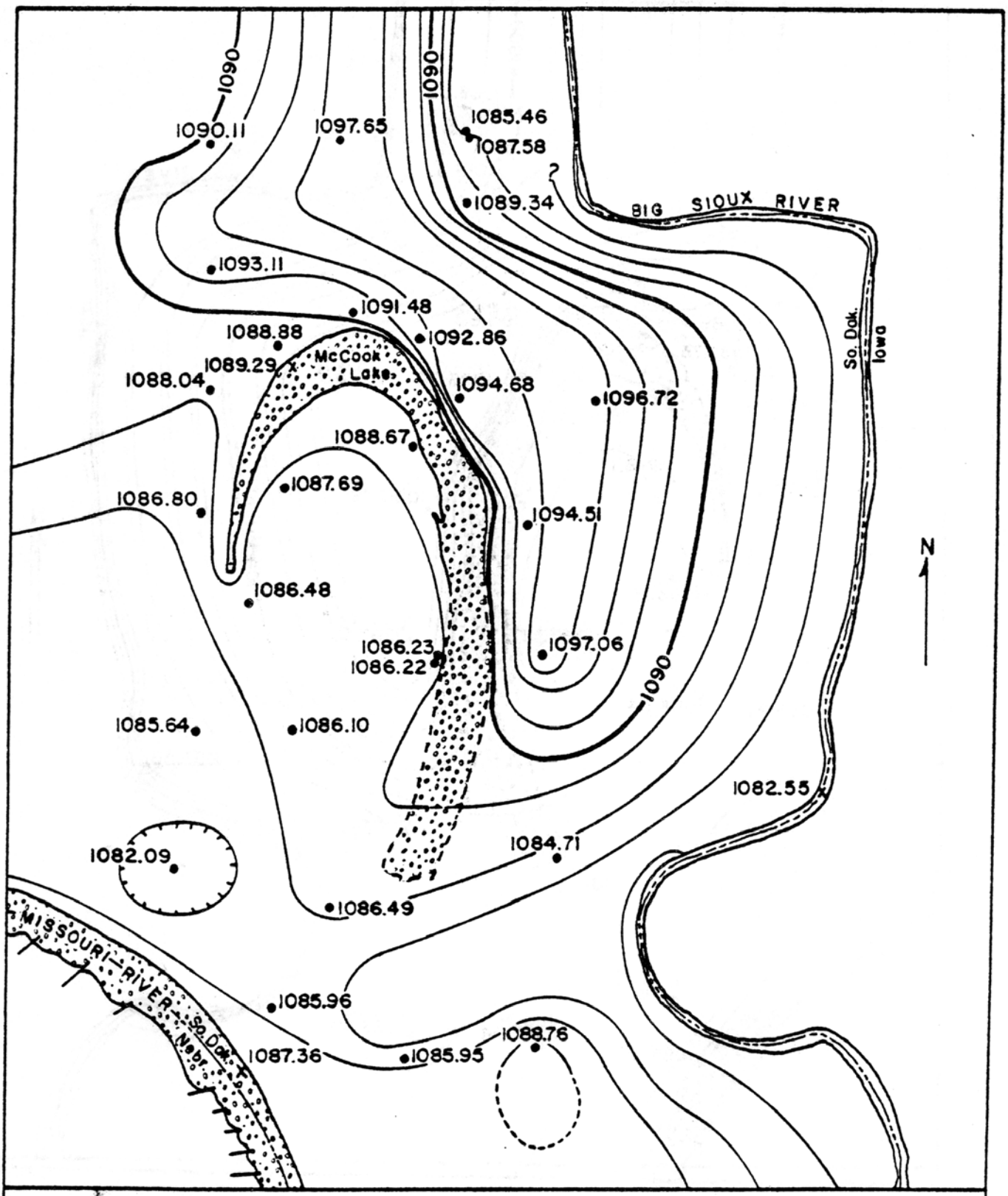
1021.11 • Observation well - number indicates water level above mean sea level.

1021.11 x Surface water - number indicates water level above mean sea level.

Contour Interval 2 feet

Data taken 6/29/78

1 Mile



Map Showing Water Table Contours

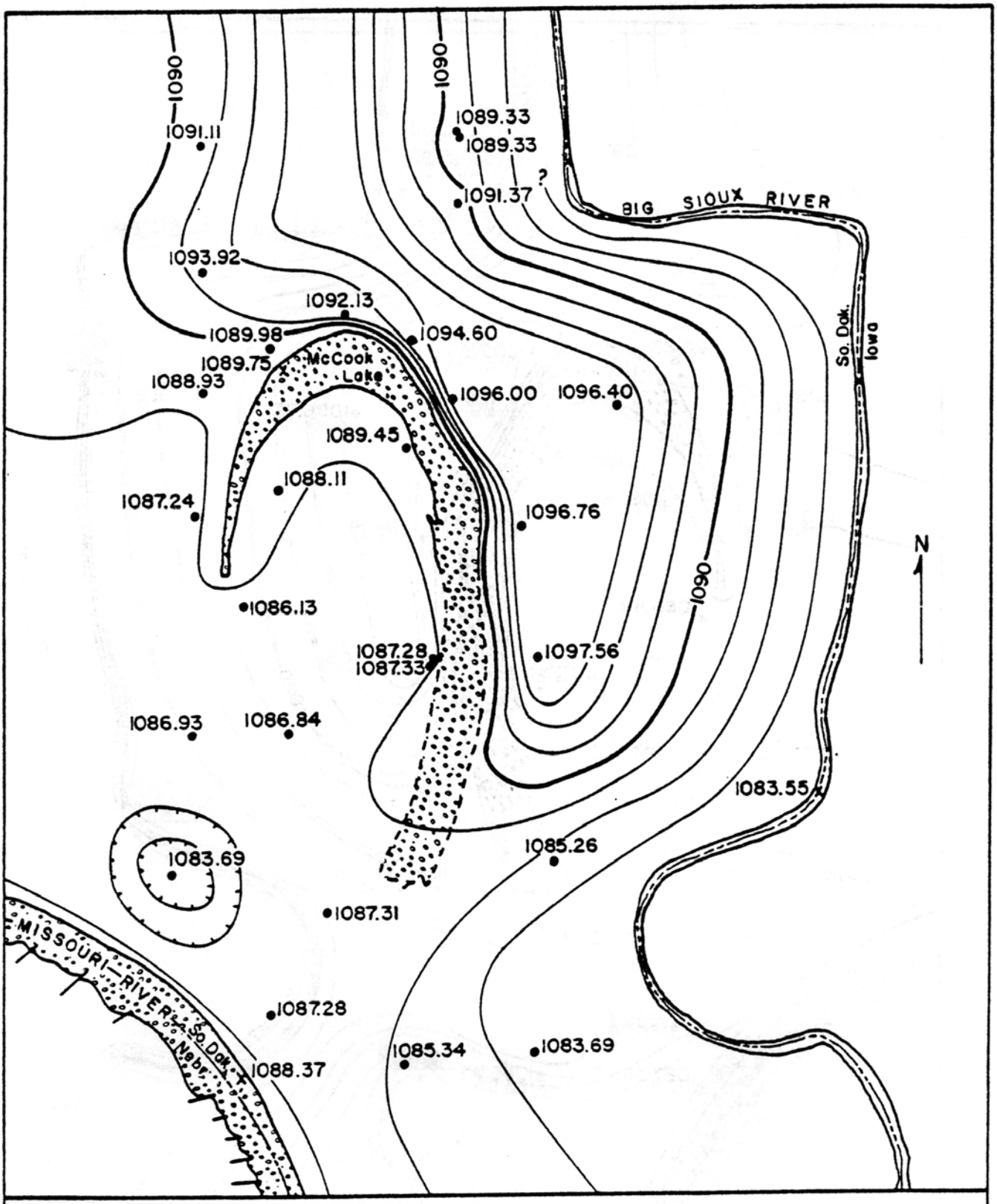
1021.11 • Observation well - number indicates water level above mean sea level.

1021.11 x Surface water - number indicates water level above mean sea level.

Contour Interval 2 feet

Data taken 7/17/78

1 Mile



Map Showing Water Table Contours

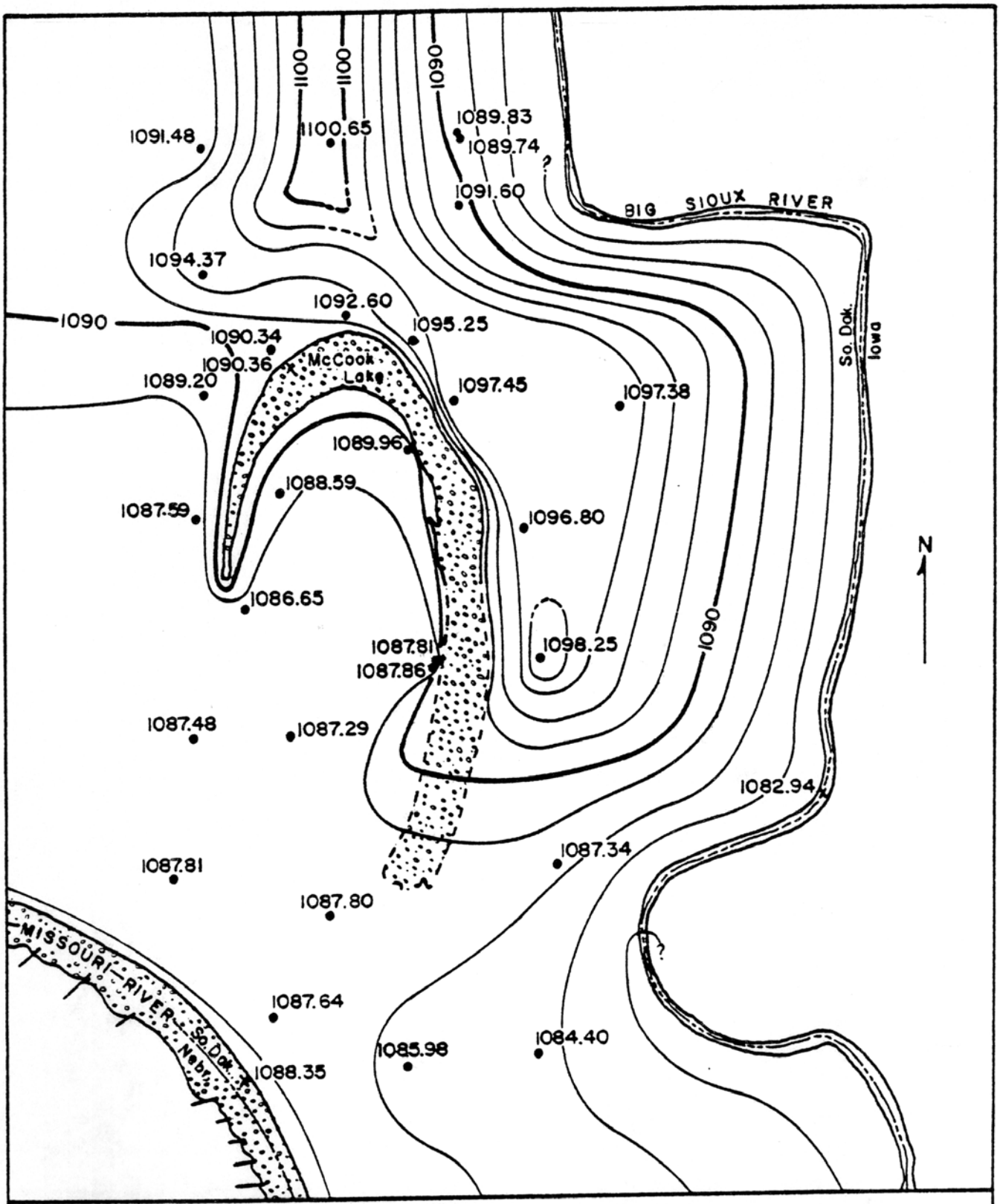
1021.11 • Observation well - number indicates water level above mean sea level.

1021.11 x Surface water - number indicates water level above mean sea level.

Contour Interval 2 feet

Data taken 7/28/78

1 Mile



Map Showing Water Table Contours

1021.11 • Observation well - number indicates water level above mean sea level.

1021.11 x Surface water - number indicates water level above mean sea level.

Contour Interval 2 feet

Data taken 8/11-14/78

1 Mile