"BUY NORTH DAKOTA PRODUCTS"

TEST DRILLING NEAR BEULAH, NORTH DAKOTA

By
Edward Bradley and H. M. Jensen
Geological Survey
United States Department of the Interior

NORTH DAKOTA GROUND WATER STUDIES

NO.40

Prepared by the United States Geological Survey in cooperation with the North Dakota State Water Conservation Commission, and the North Dakota Geological Survey

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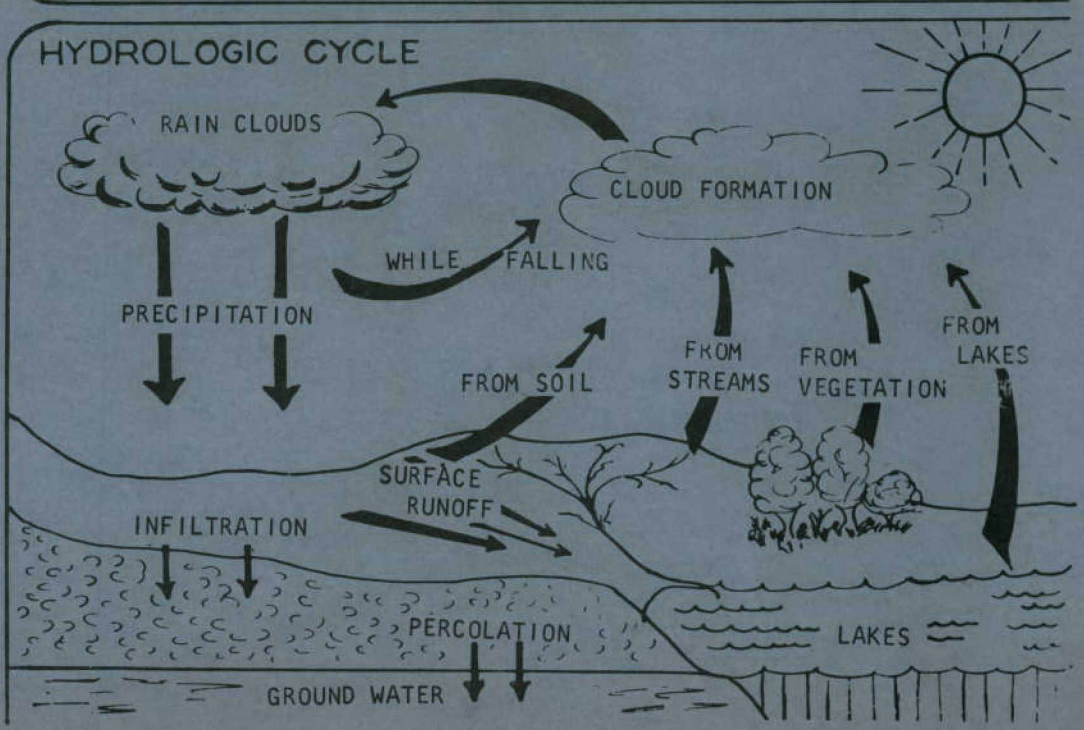

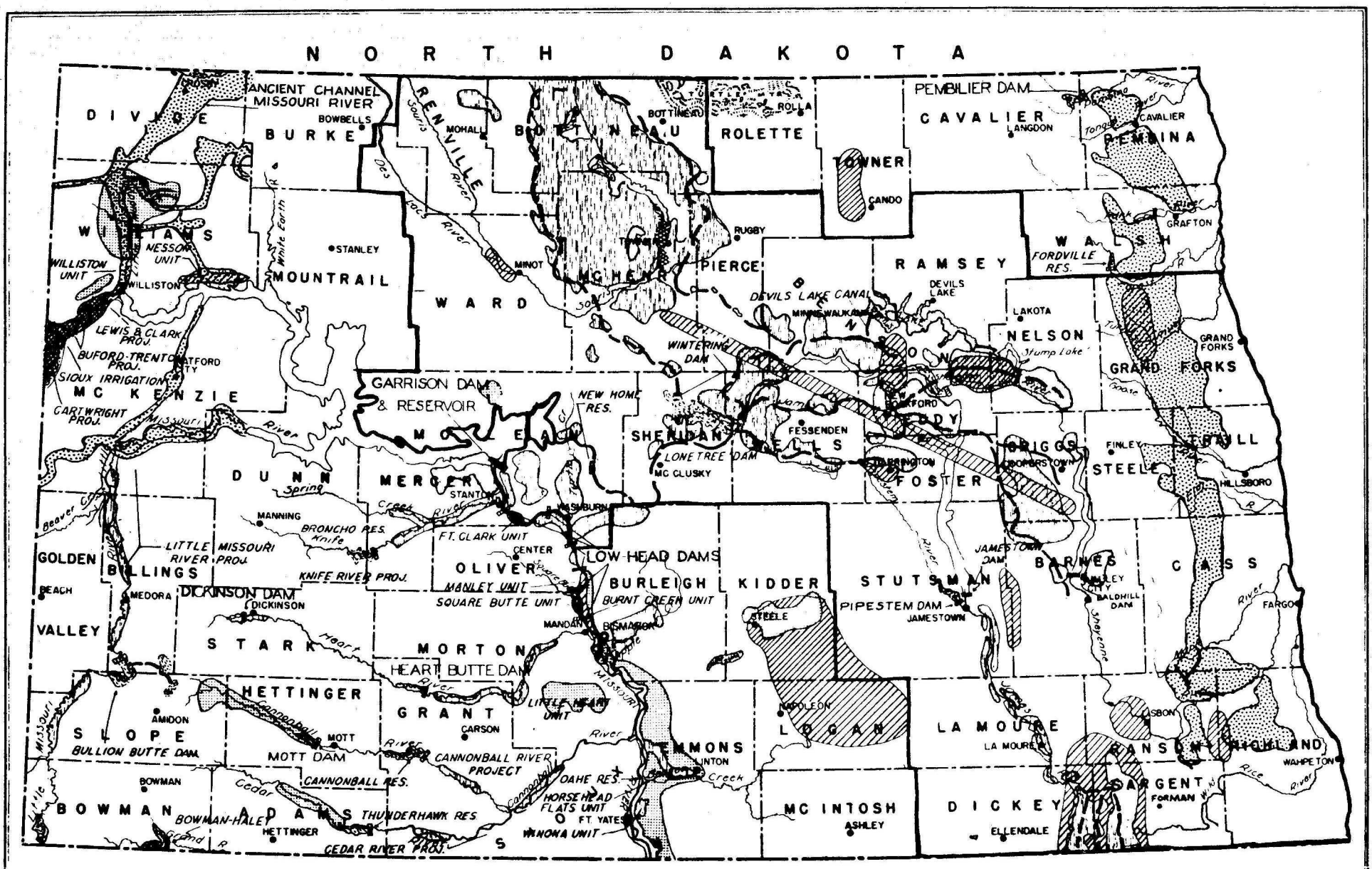

NORTH DAKOTA STATE WATER CONSERVATION COMMISSION

WATER RESOURCES DEVELOPMENT PLAN

LANDS UNDER IRRIGATION

AREAS CONSIDERED IRRIGABLE

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PROPOSED FOR INVESTIGATION

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TEST DRILLING NEAR BEULAH, MERCER COUNTY, NORTH DAKOTA

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Introduction

As a part of the cooperative ground-water investigations program, the North Dakota State Water Conservation Commission, the North Dakota Geological Survey, and the United States Geological Survey make studies of the ground-water resources available for municipal use in various parts of North Dakota. Investigations are made of small areas surrounding towns which have requested aid from the North Dakota State Water Conservation Commission or the State Geologist. When adequate funds become available, more complete investigations will be made of larger areas, such as counties. Reports on the larger investigations will include the results of the small municipal water-supply studies.

The present investigation, made at the request of the City Council of Beulah, was started in 1960. This study was needed because the present (196 water supply is inadequate to meet current water demands. The objective of the investigation was to suggest the location of additional ground-water sources in the Beulah area. The study included test drilling, evaluation of selected data, and preparation of the report.

Well-Numbering System

The well-numbering system used in this report, illustrated in figure 1, is based upon the location of the well in the federal system of rectangular surveys of the public lands. The first numeral denotes the township north of the base line, the second numeral denotes the range west of the fifth principal meridian, and the third numeral denotes the section in which the well is located. The letters a, b, c, and d designate respectively the northeast, northwest, southwest, and southeast quarter sections, quarter-quarter sections, and quarter-quarter-quarter sections (10-acre tracts). Thus, well 144-88-25bcc is in the $SW\frac{1}{4}SW\frac{1}{4}NW\frac{1}{4}$ sec. 25, T. 144 N., R. 88 W. Consecutive terminal numerals are added if more than one well is shown in a 10-acre tract.

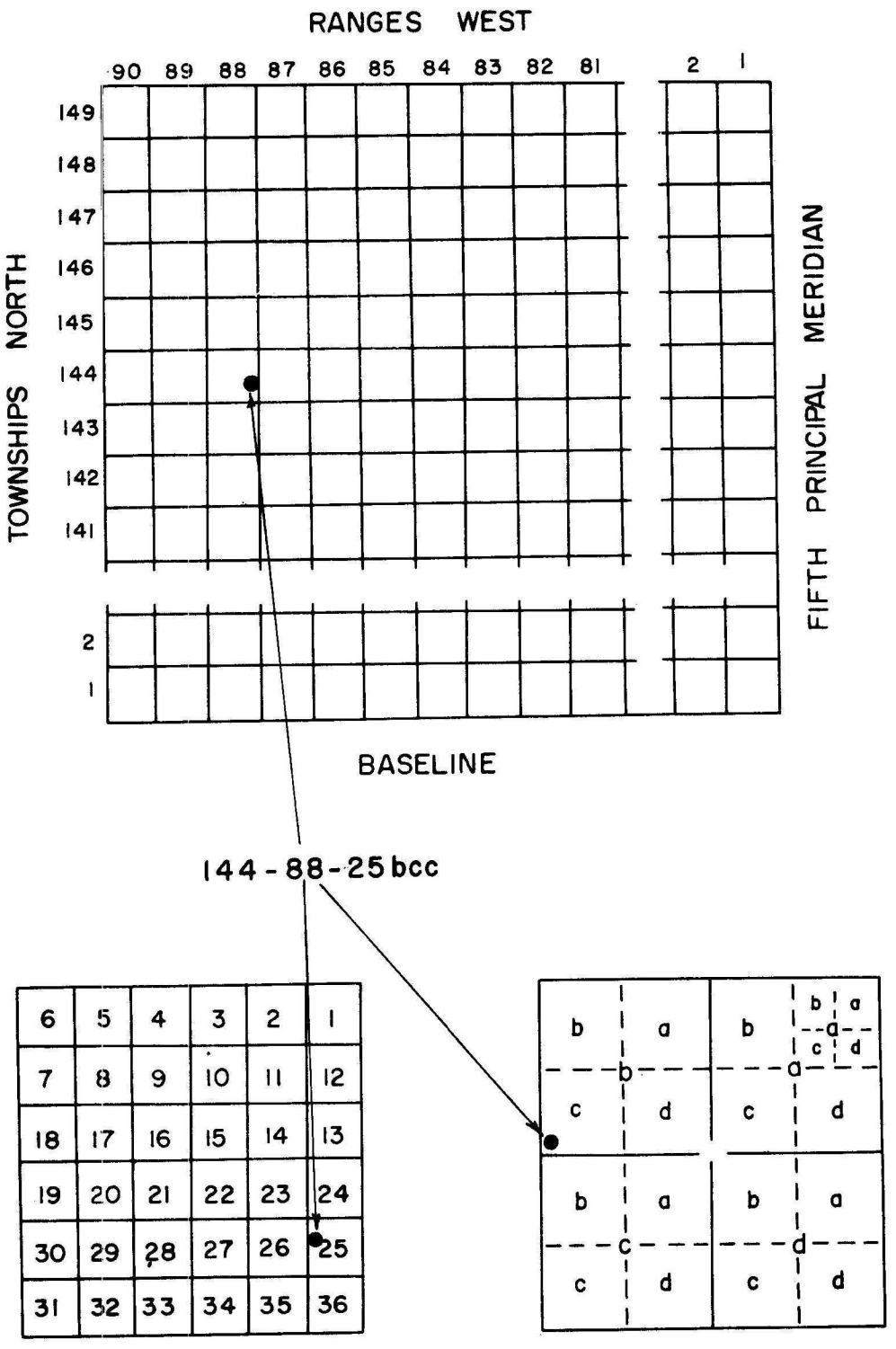


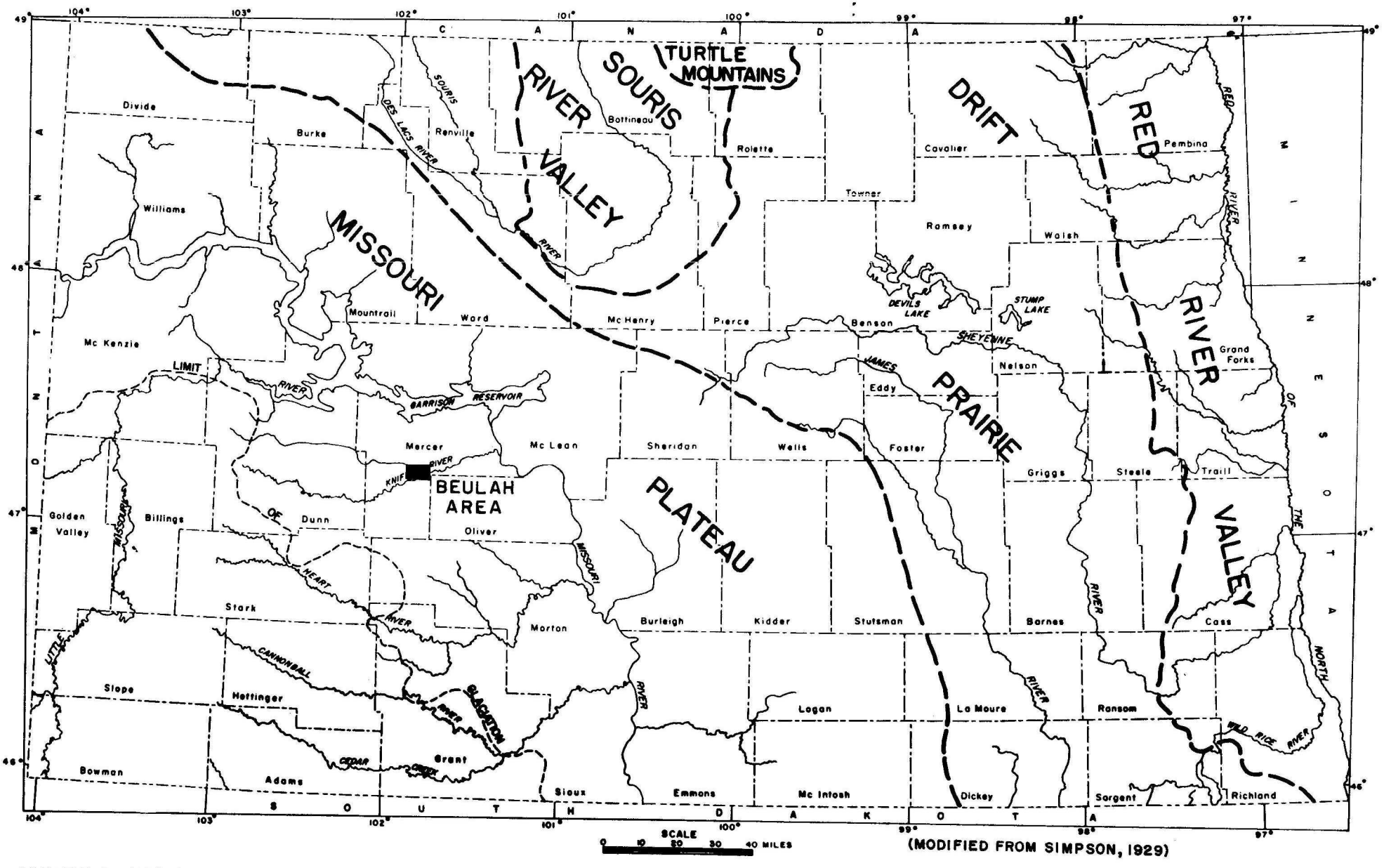
Figure 1 -- Sketch illustrating well-numbering system

Geography and General Geology

Beulah is in the Missouri Plateau province (Simpson, 1929, p. 10-11) in the west-central part of North Dakota, about 60 airline miles northwest of Bismarck. (See fig. 2.) The city is served by a branch line of the Northern Pacific Railroad and by State Highway 49. The population of Beulah in the 1960 census was 1,318.

The Knife River flows through a valley about 1 to 1½ miles wide immediately south of Beulah, and is joined by Spring Creek (fig. 3) about 1 mile southwest of Beulah. The valley of Spring Creek varies in width; it is about half a mile wide in the report area. The average discharge of the Knife River at Hazen, about 8 miles downstream (east) from Beulah, for the period 1937-58, was 198 cfs (cubic feet per second). The average discharge of Spring Creek at Zap, about 8 miles upstream (west) from Beulah, was 43.6 cfs for the period 1945-58 (Wells, 1960). At times no flow has been reported at Zap. Low flows ordinarily occur in the late summer and fall, and maximum flows occur in the spring when snowmelt and precipitation contribute most to stream runoff. The average annual precipitation in the Beulah area is about 15 inches.

The Tongue River Member of the Fort Union Formation of Paleocene age is exposed on the sides of the valleys of the Knife River and Spring Creek. The formation consists of alternating beds of clay and silt, sandstone, and lignite. Alluvial and colluvial deposits of Quaternary age occupy the valleys and lower slopes of the two streams. The upland area surrounding Beulah is covered by a thin, discontinuous mantle of glacial drift, which is not thick enough to be a source of ground water.



(MODIFIED FROM SIMPSON, 1929)

FIGURE 2--MAP SHOWING PHYSIOGRAPHIC PROVINCES IN NORTH DAKOTA AND LOCATION OF THE BEULAH AREA.

Ground-Water Conditions

Aquifers in alluvium and colluvium in parts of the Knife River valley are capable of yielding small to moderate supplies of ground water. The graphic logs of some of the test holes in the lines A-A', B-B', and C-C' (fig. 3) across the Knife River valley, and the descriptive logs of test holes (table 3) show sand and some gravel between the land surface and a depth of about 50 feet. Two wells (144-88-25ccal and 144-88-25cca2, table 1) that are used to supply Beulah obtain water from the sand and gravel beds of the alluvium and colluvium. Results of pumping tests in 1953 made on the two wells indicated that a reduction in yield was probably due to plugging of the gravel packs or screens of the wells.

The channel of the Knife River and aquifers in the alluvium and colluvium may be hydraulically connected at places. Wells in permeable deposits near the river may provide moderately large sustained yields, owing to induced recharge of the alluvium by river water.

Ground water may be obtained from lignite and sandstone layers in the Tongue River Member of the Fort Union Formation. In the major drainage courses and along the valley slopes it is possible to complete shallow wells (less than 100 feet deep) in bedrock. At locations outside the Knife River valley, Simpson (1929, p. 169-170) reports, small quantities of ground water are obtained from the Fort Union, generally from considerable depths, such as about 100 to 350 feet.

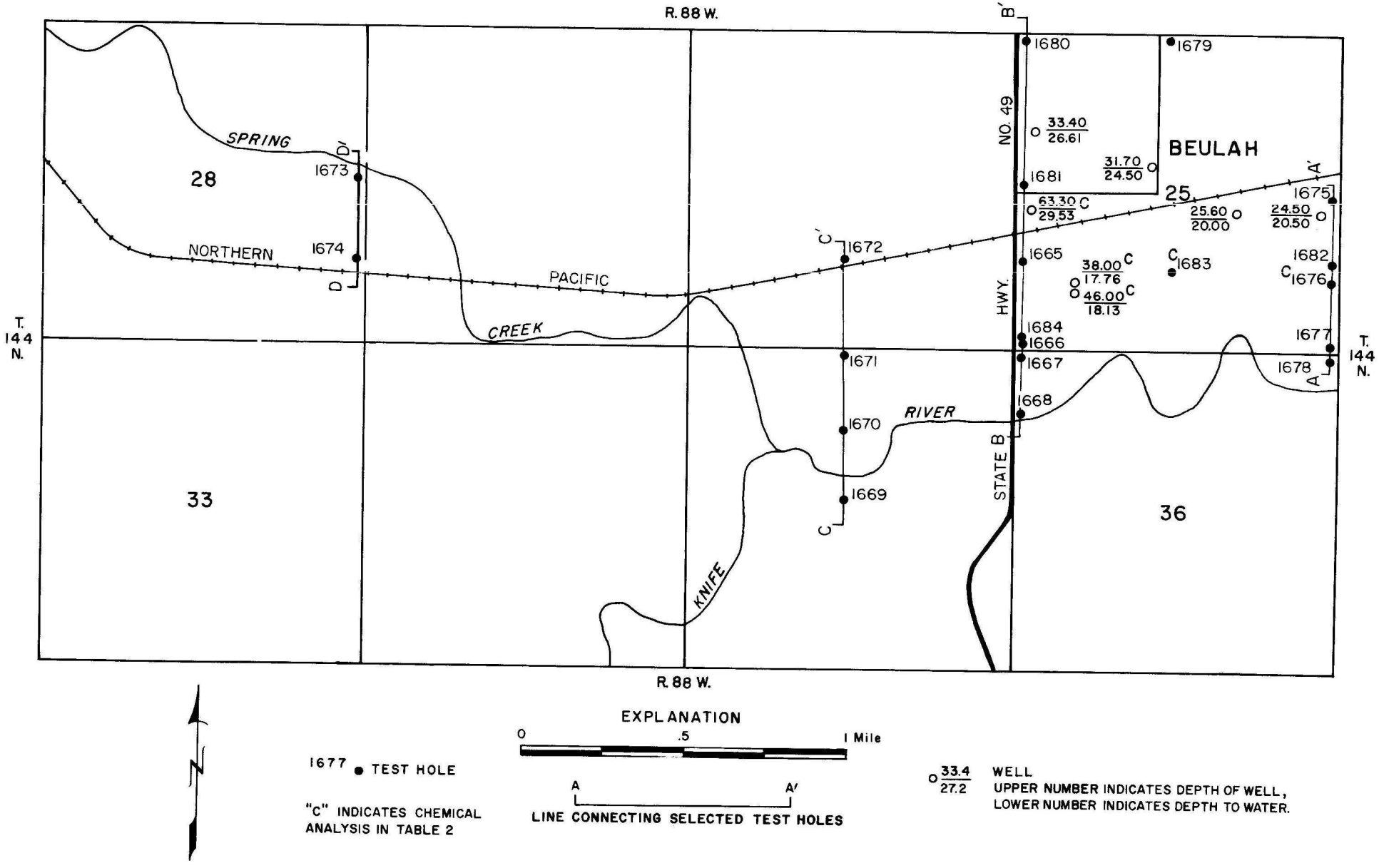


FIGURE 3--MAP SHOWING LOCATION OF SELECTED WELLS AND TEST HOLES IN THE BEULAH AREA.

Quality of Water

Table 2 lists the mineral constituents and concentrations found in water from aquifers in the alluvial and colluvial deposits and the Fort Union Formation. The water from the alluvial and colluvial deposits differs; water from two wells was of the sodium bicarbonate type, that from one well was of the sodium sulfate type, and that from a fourth well was of the calcium bicarbonate type. In general the water from these deposits is very hard. (See table 2.) The iron content generally exceeds the limit of 0.3 ppm (parts per million) recommended by U.S. Public Health Standards (1946); however, proper treatment could greatly reduce the amount of iron. Furthermore, if sufficient ground water is pumped from wells close to the Knife River to induce recharge from the river into the alluvium, the objectionably high iron content of the ground water might be lessened because the iron content of the stream is negligible (Love, 1955, p. 202).

Well 144-88-25cbb indicates that water from the Fort Union Formation is predominantly a sodium bicarbonate solution, has a high dissolved-solids content, and has a relatively low hardness. The iron concentration in the water is much less than that in water from the alluvium and colluvium. The water is not hard and ordinarily can be used for most domestic purposes; however, because it has a high dissolved-solids content and may contain an objectionable taste or color, it is not satisfactory for municipal use.

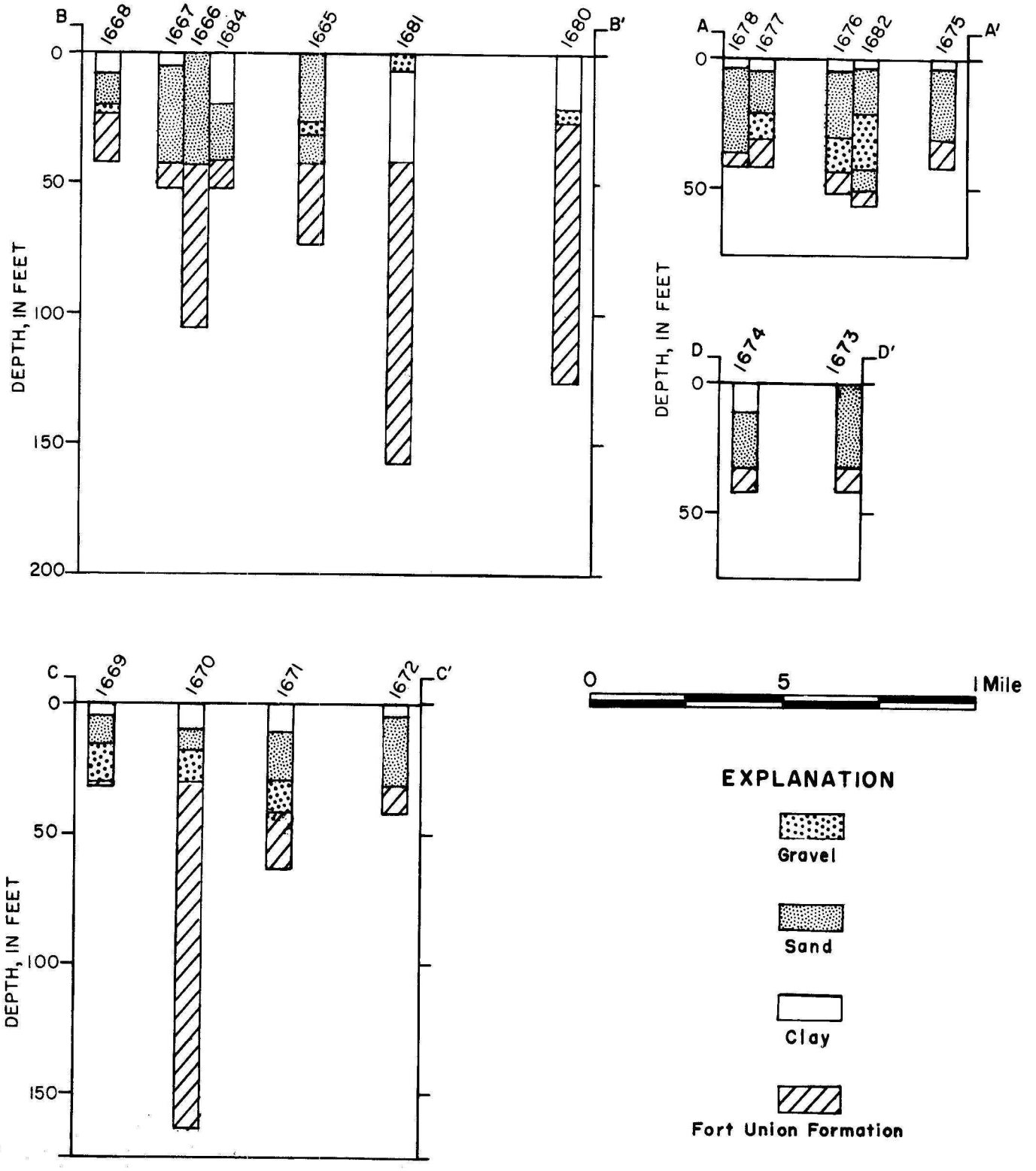


FIGURE 4--GRAPHIC LOGS OF SELECTED TEST HOLES
(LOCATION OF TEST HOLES SHOWN IN FIGURE 3)

Conclusions and Suggestions

The investigation of the Beulah area shows that the most important source of water for municipal development is contained in aquifers in the alluvium and colluvium in the Knife River valley. Wells properly constructed and developed in the coarser materials of the aquifers should provide sufficient water for Beulah's present (1961) needs. Also, induced recharge from streamflow may be possible through wells located relatively close to the Knife River. Generally the water in alluvial and colluvial deposits is hard and contains iron in objectionable quantities. Proper treatment facilities or induced recharge from streamflow could greatly reduce the iron concentration.

Aquifers in the sand and lignite beds of the Tongue River Member of the Fort Union Formation supply small quantities of water to wells. Generally, the water contains concentrations of dissolved solids exceeding the recommended limits established by the U.S. Public Health Standards. The high concentration of dissolved solids, often accompanied by an objectionable taste or color, makes the water undesirable for municipal supply.

TABLE 1.--Records of wells

Depth: Measured depths are given in feet and tenths; reported depths are given in feet.
Type of well: Dr, drilled; Du, dug.

Location No.	Owner or name	Depth of well (feet)	Diameter or size (inches)	Type	Date completed
144-88					
25baa	Test hole 1679	504	5	Dr	4-16-60
25bbb	Test hole 1680	126	5	Dr	4-19-60
25bcb	Jake Weiss	33.4	48	Du	.....
25bcc	Test hole 1681	157	5	Dr	4-20-60
25bdd	Mike Fetch	31.7	12	Dr	.....
25cad	Test hole 1683	52	5	Dr	4-21-60
25cba	Jacob Schutt	34.2	36	Dr	1938
25cbb	John Meyers	63.3	..	Dr	.....
25cbc	Test hole 1665	73.5	5	Dr	4- 6-60
25ccal	City well 1	38.0	16	Dr	1952
25cca2	City well 2	46.0	16	Dr	1953
25ccc1	Test hole 1684	52	5	Dr	4-22-60
25ccc2	Test hole 1666	105	5	Dr	4- 6-60
25daa1	N. F. Kirchen	24.5	48	Du	.....
25daa2	Test hole 1675	42	5	Dr	4-14-60
25dad	Test hole 1682	57	5	Dr	4-21-60
25dba	Mrs. Ben Kittler	25.6	...	..	.....
25dda	Test hole 1676	52	5	Dr	4-14-60
25ddd	Test hole 1677	42	5	Dr	4-16-60
26cad	Test hole 1672	42	5	Dr	4-13-60
28add	Test hole 1673	42	5	Dr	4-14-60
28dad	Test hole 1674	42	5	Dr	4-14-60
35baa	Test hole 1671	63	5	Dr	4-13-60
35bda	Test hole 1670	168	5	Dr	4-12-60
35bdd	Test hole 1669	31.5	5	Dr	4- 8-60
36aaa	Test hole 1678	42	5	Dr	4-15-60
36bbb	Test hole 1667	52	5	Dr	4- 9-60
36bbc	Test hole 1668	42	5	Dr	4- 7-60

and test holes

Use of water: D, domestic; PS, public supply; T, test hole.

Depth to water below land surface (feet)	Date of measurement	Use of water	Aquifer	Remarks
.....	.....	T	.....	See log.
.....	.....	T	.....	Do.
26.61	4- 5-60	D	.....	Water level 27.2 feet below land surface in 1946.
.....	.....	T	.....	See log.
24.5	1946	D	Gravel	
.....	.....	T	.....	Do.
28.10	4- 5-60	D	Sand	Water level 29.3 feet below land surface in 1946.
29.53	5- ?-47	D	.....	
.....	.....	T	.....	See log.
17.76	2- 8-53	PS	Gravel	Reported yield, 90 gpm.
18.13	2- 8-53	PS	..do..	
.....	.....	T	.....	See log.
.....	.....	T	.....	Do.
20.5	1946	D	.....	Plugged.
.....	.....	T	.....	See log.
.....	.....	T	.....	Do.
20.00	1946	D	.....	
.....	.....	T	.....	Do.
.....	.....	T	.....	Do.
.....	.....	T	.....	Do.
.....	.....	T	.....	Do.
.....	.....	T	.....	Do.
.....	.....	T	.....	Do.
.....	.....	T	.....	Do.
.....	.....	T	.....	Do.
.....	.....	T	.....	Do.
.....	.....	T	.....	Do.
.....	.....	T	.....	Do.

TABLE 2.--Chemical analyses

Aquifer: R, alluvium and colluvium
Tft, Tongue River Member of the Fort Union Formation

Location No.	Owner or name	Aquifer	Depth of well (feet)	Date of collection	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)
144-88									
25cad	Test hole 1683	R	52	5-60	..	5.6	61	37	80
25cbb	John Meyers a/	Tft	63.3	5-47	11	.2	12	5.9	504
25cca1	City well 1	R	38	7-52	..	.25	53	24	65
25cca2	City well 2	R	46	7-52	..	1.3	58	22	41
25dda	Test hole 1676	R	52	5-60	..	17	193	75	278

a/Analysis by U.S. Geological Survey

of ground water

Analyses by State Laboratories, Bismarck
Results in parts per million except as indicated

Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Hardness as $CaCO_3$	Dissolved solids (residue at 180°C)	pH
5.0	348	0	152	0.0	0.1	0.0	0.25	308	540	8.1
7.2	1,020	79	190	.0	1.1	1.8	.23	54	1,330	...
...	371	0	55	8.0	.15	...	....	232	576	8.0
...	325	0	45	8.0	.1	...	....	236	500	7.8
6.0	616	0	761	11	.1	.0	.2	791	1,790	7.7

TABLE 3.--Logs of test holes

144-88-25baa
Test hole 1679

Formation	Material	Thickness (feet)	Depth (feet)
Alluvium and colluvium:			
	Topsoil, silty, brown	3	3
	Clay, brittle, plastic, light-gray	18	21
	Clay, silty, sandy, gray-yellow; some limestone cobbles	22	43
Fort Union Formation:			
Tongue River Member:			
	Sand, very fine to medium, gray; large lignite fraction	9	52
	Clay, silty and sandy; trace of iron nodules, scoria, and lignite	21	73
	Sand, very fine to medium, silty, yellowish- to greenish-gray	51	124
	Clay, brittle, plastic, light-gray; some lignite fragments	47	171
	Lignite	13	184
	Clay, silty, olive-gray	5	189
	Clay, brittle, light-gray	31	220
	Clay, brittle, gray; lignite fragments and thin stringers of limestone	41	261
	Limestone, very fine grained, silty, gray to light-gray	12	273
	Lignite, shaly, platy, black to dark-brown	10	283
	Clay, silty and sandy, light-gray	21	304
	Clay, brittle, gray; thin stringers of lignitic shale	42	346
	Clay, silty, sandy, dark-brown; lignitic shale	11	357
	Clay, sandy, light-gray	31	388
	Shale, platy, carbonaceous	11	399
	Clay, sandy and plastic, dark-gray to gray	31	430
	Sand, very fine, clayey, olive-gray; lignite fragments	53	483
	Clay, very sandy, light-gray to olive-gray	21	504

TABLE 3.--Logs of test holes -- Continued

144-88-25bbb
Test hole 1680

Formation	Material	Thickness (feet)	Depth (feet)
Alluvium and colluvium:			
	Topsoil, brown.....	1	1
	Clay, silty, sandy, light-brown to yellowish-brown; with trace of scoria and pebbles.....	20	21
	Gravel, granular to pebbly; scoria, iron concretions, lignite fragments.....	5	26
Fort Union Formation:			
Tongue River Member:			
	Clay, brittle, cohesive, gray.....	17	43
	Clay, sandy, dark-gray.....	20	63
	Clay, sandy, light-gray; iron concretions and scoria fragments.....	63	126

144-88-25bcc
Test hole 1681

Alluvium and colluvium:			
	Topsoil, clayey, sandy, brown.....	3	3
	Gravel, granule to pebbly, clayey; medium to coarse sand.....	3	6
	Clay, brittle, yellowish-gray.....	15	21
	Clay, sandy, light-tan.....	20	41
Fort Union Formation:			
Tongue River Member:			
	Clay, cohesive and brittle, dark-gray and brownish-gray; lignite fragments...	32	73
	Clay, sandy, light-gray to dark-gray.....	11	84
	Sand, very fine to fine, clayey, light-gray; lignite fragments.....	38	122
	Clay, brittle, plastic, gray.....	21	143
	Lignite, black.....	5	148
	Clay, sandy, gray; large lignite fraction	9	157

TABLE 3.--Logs of test holes -- Continued

144-88-25cad
Test hole 1683

Formation	Material	Thickness (feet)	Depth (feet)
Alluvium and colluvium:			
	Topsoil, silty, brown.....	1	1
	Clay, sandy, silty, light-brown.....	9	10
	Sand, very fine to coarse, silty; granule gravel and lignite fragments.....	10	20
	Gravel, granule to cobbles; coarse sand; iron concretions, scoria and lignite fragments.....	20	40
	Sand, very fine to coarse, clean.....	12	52

144-88-25cbc
Test hole 1665

Alluvium and colluvium:			
	Topsoil, sandy, brown.....	1	1
	Sand, very fine to fine, silty, dark-gray; granule gravel and lignite fragments...	15	16
	Sand, very fine to coarse, silty, gray...	5	21
	Sand, very fine to coarse, clean.....	5	26
	Gravel, granule; coarse sand and lignite fragments.....	5	31
	Sand, very fine to coarse; lignite fragments.....	11	42
Fort Union Formation:			
Tongue River Member:			
	Lignite, black.....	2	44
	Sand, very fine to coarse; large lignite fraction.....	19	63
	Clay, silty, sandy, light-gray, very calcareous; scoria and iron nodules....	10½	73½

TABLE 3.--Logs of test holes -- Continued

144-88-25ccc1
Test hole 1684

Formation	Material	Thickness (feet)	Depth (feet)
Alluvium and colluvium:			
	Topsoil, sandy, brown.....	1	1
	Clay, silty, sandy, yellowish-brown.....	19	20
	Sand, very fine to coarse, brown; lignite and scoria fragments.....	21	41
Fort Union Formation:			
Tongue River Member:			
	Clay, sandy, brittle, gray, very calcareous.....	11	52

144-88-25ccc2
Test hole 1666

Alluvium and colluvium:			
	Topsoil, silty, brown.....	3	3
	Sand, fine, silty.....	8	11
	Sand, fine to coarse; lignite fragments..	21	32
	Sand, coarse; fine gravel; lignite fragments.....	11	43
Fort Union Formation:			
Tongue River Member:			
	Sand, fine, clayey; thin lignite beds....	54	97
	Clay, sandy, gray.....	8	105

144-88-25daa2
Test hole 1675

Alluvium and colluvium:			
	Topsoil, silty, sandy, gray.....	1	1
	Clay, silty, sandy, gray.....	3	4
	Sand, very fine to coarse, iron-stained; granule gravel and some lignite and scoria fragments.....	18	22
	Sand, very fine to coarse, gray.....	9	31
Fort Union Formation:			
Tongue River Member:			
	Clay, silty, sandy, light-gray, very calcareous.....	11	42

TABLE 3.--Logs of test holes -- Continued

144-88-25dad
Test hole 1682

Formation	Material	Thickness (feet)	Depth (feet)
Alluvium and colluvium:			
	Topsoil, silty, sandy, brown.....	1	1
	Clay, silty, sandy, gray-brown.....	3	4
	Sand, fine to coarse; angular to round, well-sorted.....	17	21
	Gravel, granule to pebbly; medium and coarse sand, lignite and scoria fragments.....	21	42
	Sand, very fine to coarse; granule gravel, iron concretions, lignite and scoria fragments.....	9	51
Fort Union Formation:			
Tongue River Member:			
	Lignite, black.....	6	57

144-88-25dda
Test hole 1676

Alluvium and colluvium:			
	Topsoil, sandy, light-brown.....	1	1
	Clay, silty, sandy, light-brown.....	4	5
	Sand, very fine to medium, silty; lignite fragments.....	6	11
	Sand, fine to coarse; lignite fragments..	11	22
	Sand, very fine to coarse; granule gravel; lignite and scoria fragments.....	8	30
	Gravel, granular to bouldery; iron nodules, scoria and lignite fragments..	14	44
Fort Union Formation:			
Tongue River Member:			
	Clay, silty, sandy, light-gray; very calcareous.....	8	52

TABLE 3.--Logs of test holes -- Continued

144-88-25ddd
Test hole 1677

Formation	Material	Thickness (feet)	Depth (feet)
Alluvium and colluvium:			
	Topsoil, sandy, light-brown.....	1	1
	Clay, very silty and sandy, light-brown..	4	5
	Sand, very fine to coarse; granule and pebbly gravel; lignite and scoria fragments.....	16	21
	Gravel, granule to pebbly; medium to coarse sand; lignite and scoria fragments.....	11	32
Fort Union Formation:			
Tongue River Member:			
	Clay, silty, sandy, light-gray; very calcareous.....	10	42

144-88-26cad
Test hole 1672

Alluvium and colluvium:			
	Topsoil, silty, dark-brown.....	1	1
	Clay, silty, brown.....	4	5
	Sand, very fine to medium.....	6	11
	Sand, very fine to coarse.....	9	20
	Sand, very fine to coarse; some granule gravel.....	11	31
Fort Union Formation:			
Tongue River Member:			
	Clay, sandy, brittle, light-gray; calcareous.....	11	42

TABLE 3.--Logs of test holes -- Continued

144-88-28add
Test hole 1673

Formation	Material	Thickness (feet)	Depth (feet)
Alluvium and colluvium:			
	Topsoil, sandy, brown.....	1	1
	Sand, very fine to coarse; lignite fragments.....	20	21
	Sand, very fine to coarse, silty and clayey; some granule gravel.....	11	32
Fort Union Formation:			
Tongue River Member:			
	Clay, sandy, light-gray; calcareous.....	10	42

144-88-28dad
Test hole 1674

Alluvium and colluvium:			
	Topsoil, silty and sandy, brown.....	1	1
	Clay, silty, sandy, brownish-gray.....	10	11
	Sand, very fine to coarse, iron-stained; granule, pebbly gravel, and lignite fragments.....	10	21
	Sand, very fine to coarse; large lignite fraction and some gray silty clay.....	12	33
Fort Union Formation:			
Tongue River Member:			
	Clay, silty, sandy, light-gray; very calcareous.....	9	42

TABLE 3.--Logs of test holes -- Continued

144-88-35baa
Test hole 1671

Formation	Material	Thickness (feet)	Depth (feet)
Alluvium and colluvium:			
	Topsoil, silty, brown.....	1	1
	Clay, silty, sandy, light-brown; granule gravel and lignite fragments.....	10	11
	Sand, very fine to coarse, silty and clayey; granule gravel and lignite fragments.....	18	29
	Gravel, granule to bouldery; medium and coarse sand.....	12	41
Fort Union Formation:			
Tongue River Member:			
	Clay, brittle, sandy, light-gray; very calcareous.....	22	63

144-88-35bda
Test hole 1670

Alluvium and colluvium:			
	Topsoil, silty, brownish-gray.....	1	1
	Clay, silty, sandy, gray.....	9	10
	Sand, very fine to coarse, silty; granule gravel.....	8	18
	Gravel, granule to bouldery.....	4	22
	Gravel, granule to bouldery; largely rounded lignite fragments with some fine to coarse sand.....	8	30
Fort Union Formation:			
Tongue River Member:			
	Sand, very fine to coarse, silty; some granule gravel from above; larger lignite fraction.....	43	73
	Sand, very fine to coarse, silty; large lignite fraction.....	95	168

TABLE 3.--Logs of test holes -- Continued

144-88-35bdd
Test hole 1669

Formation	Material	Thickness (feet)	Depth (feet)
Alluvium and colluvium:			
	Topsoil, clayey, brownish-gray.....	1	1
	Clay, silty, brown.....	4	5
	Sand, very fine to medium; lignite fragments.....	6	11
	Gravel, granule to pebbly; medium to coarse sand and lignite fragments.....	9	20
	Gravel, granule to pebbly.....	10	30
Fort Union Formation:			
Tongue River Member:			
	Lignite, black; drilling sample contains unusually large lignite fragments.....	½	30½
	Lost circulation; hole abandoned		

144-88-36aaa
Test hole 1678

Alluvium and colluvium:			
	Topsoil, silty, sandy, brown.....	1	1
	Clay, very silty, sandy, brown.....	3	4
	Sand, very fine to coarse.....	18	22
	Sand, very fine to coarse; large lignite fraction.....	15	37
Fort Union Formation:			
Tongue River Member:			
	Clay, silty, sandy, light-gray; very calcareous.....	5	42

TABLE 3.--Logs of test holes -- Continued

144-88-36bbb
Test hole 1667

Formation	Material	Thickness (feet)	Depth (feet)
Alluvium and colluvium:			
	Topsoil, silty, brown.....	1	1
	Clay, sandy, gray-brown.....	4	5
	Sand, very fine to coarse; lignite and shale fragments.....	37	42
Fort Union Formation:			
Tongue River Member:			
	Clay, brittle, sandy, light-gray; very calcareous.....	10	52

144-88-36bbc
Test hole 1668

Alluvium and colluvium:			
	Topsoil, silty, brownish-gray.....	1	1
	Clay, silty, gray.....	7	8
	Sand, fine; lignite fragments.....	12	20
	Gravel, granule; lignite fragments.....	4	24
Fort Union Formation:			
Tongue River Member:			
	Clay, silty, greenish-gray, calcareous...	18	42

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